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Memorandum

SUBJECT: EFED RED Chapter for Tribufos

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Attached please find the following documents for the completed RED for tribufos:

1. Summary report
2. Integrated EFED RED chapter
3. EFGWB science chapter
4. EEB science chapter

There are numerous LOC exceedances for this chemical and several data gaps. These and other issues are discussed in the following summary report.

If you have any questions about this case, please call Mary Powell on 305-7384.

RED Summary Report

I. Introduction

Tribufos is a defoliant used to remove leaves from cotton plants prior to anticipated harvesting. The maximum application rate is 1.875 lb ai/acre. It is applied preharvest by spray (aircraft and ground) and ultra low volume (aircraft and ground).

The environmental fate of tribufos has been well characterized in the laboratory, though its behavior in the field is not yet clearly understood. Based on laboratory data, tribufos is persistent and immobile, thus the possibility exists that tribufos will accumulate in soil with repeated applications. The primary route of dissipation appears to be anaerobic metabolism under flooded conditions, with a half-life of 4-6 months. Tribufos is stable to hydrolysis, photodegradation, and aerobic soil metabolism. It is only moderately soluble in water and has a fairly low vapor pressure.

Tribufos binds to soil and is, therefore, not expected to leach to ground water or move to surface water through dissolved runoff. Freundlich K_{ads} values ranged from 61-106 in sand, sandy loam, silt loam, and clay loam soils. K_{oc}s ranged from 4870-12684. Aged tribufos residues were also not mobile, with 90-99% of the applied remaining in the 0-6 cm layer of the soil columns.

Tribufos can contaminate surface water at application by spray drift. Substantial fractions of applied tribufos may remain available for runoff for many months post-application. The relatively high soil/water partitioning of tribufos indicates that runoff will generally occur primarily via adsorption to eroding soil as oppossed to dissolution in runoff water. In addition, the concentration of tribufos adsorbed to suspended and bottom sediment will be much greater than its concentration in sediment pore water or the water column.

Data on fish accumulation have shown that tribufos has a low potential to bioaccumulate in bluegill sunfish. Bioconcentration factors were 300X, 1300X, and 730X for edible tissues, nonedible tissues, and whole fish, respectively. Tissue residues decreased rapidly during the depuration period with 71-88% of the radioactivity eliminated after 14 days.

II. Summary of Toxicity

The available acute toxicity data on the TGAI indicate that tribufos is practically nontoxic to moderately toxic to birds (LD50s: 151 - 2,934 mg/kg; LC50s: 1519 - > 5000 ppm), moderately toxic to small mammals (LD50: 192 - 235 mg/kg), practically nontoxic to bees (LD50: > 24.17 μg/bee), very highly toxic to moderately toxic to freshwater organisms (LC50s: 0.027 ppm - 2.100 ppm), and very highly toxic to highly toxic to estuarine/marine organisms (LC50 or EC50: 0.0046 to 0.767 ppm). Chronic toxicity studies established the following NOEC values: 148 ppm for bobwhite quail; 32 ppm for small mammals; 1.56 ppb for freshwater invertebrates; and < .34 ppm for estuarine/marine invertebrates.

Nontarget terrestrial plant toxicity data are lacking; most nontarget aquatic plant toxicity data are lacking. However, data are available on a freshwater green alga (*Kirchneria subcapitata*) and a marine diatom (*Skeletonema costatum*): EC50s = 0.148 ppm and 0.370ppm, respectively.

III. Summary of Risk

A table of risk quotients (RQs) may be found on the following page, "Summary of Risk Quotients for Tribufos."

Acute risks to nonendangered birds are not likely (RQ, = .1-.3); any potential acute risks may be mitigated by restricted use classification. Chronic risks are likely (RQ = 1.03-3.04), but the probability of whether they will occur is difficult to assess.

Acute and chronic risks are likely for small mammals. Chronic risks present the highest RQ (6.38-13.94), and the certainty of this assessment is high; acute RQs range from .01-2.23 and the certainty of this assessment is moderate to high.

Aquatic risk assessments are based on exposure scenarios from three states: California, representing a dry climate; Mississippi, representing a wet climate; and Texas, a mixed climate:

- In the California scenario, acute risks to freshwater vertebrates (RQ = 0) and invertebrates (RQ = .01) are not likely. Chronic risks for freshwater invertebrates (RQ = .05) are also unlikely; chronic effects data for freshwater fish are lacking. Use of tribufos in California is not expected to affect estuarine/marine environments.

- In the Texas scenario, acute risks to freshwater vertebrates are not likely (RQ = .03). A chronic risk characterization for freshwater fish is not possible; chronic effects data are lacking. Acute risks to freshwater invertebrates (RQ = .3) may be mitigated by restricted use classification; however, chronic risks to these organisms is likely (RQ = 1.5). Endangered freshwater invertebrates are likely to be affected acutely and chronically. Acute risks to nonendangered estuarine/marine fish are not likely (RQ = .06); however, endangered estuarine/marine fish may be affected acutely. A chronic risk characterization for estuarine/marine fish is not possible; chronic effects data are lacking. Acute (RQ = 1.6) and chronic (RQ = 10) risks to estuarine/marine invertebrates, including endangered species, are likely.

- In the Mississippi scenario, endangered freshwater fish may be acutely affected. However, a chronic risk characterization for freshwater fish is not possible; chronic effects data are lacking. Acute risks to estuarine/marine fish (RQ = .11) may be mitigated by restricted use classification; however, endangered fish may be affected acutely. A chronic risk characterization for estuarine/marine fish is not possible; chronic effects data are lacking. Acute and chronic risks to freshwater invertebrates (RQ = .52 and 3.5, respectively) and estuarine/marine invertebrates (RQ = 2.8 and 23.33, respectively), including endangered species, are likely.

IV. Data Gaps

A. Ecological Effects

EFED is able to complete a partial risk characterization of tribufos using the present toxicity data. The following additional data would increase the certainty of the risk assessment:

1. **An avian reproduction study using mallard duck (71-4(b)):** Submission of this study would have a medium value since EFED was able to complete a chronic characterization for birds using the bobwhite quail reproduction study. However, submission of the mallard study would reduce uncertainty in the risk assessment since it is not known how different avian species would respond to tribufos under chronic exposure conditions.

2. **A freshwater fish early life-stage study (rainbow trout, preferred species; 71-4(a)):** Submission of this study would have a high value since EFED was unable to characterize chronic risks to nontarget fish. The available aquatic chronic data are for invertebrates only, but indicate adverse effects on aquatic invertebrate reproduction occur. Further, the available data indicate: (1) tribufos is likely to be persistent in nontarget waters (hydrosoil) because the parent is stable to hydrolysis, photolysis, and aerobic soil metabolism and ; (2) tribufos has adverse effects on avian and mammalian reproduction (in addition to aquatic invertebrate reproduction); and (3) tribufos is used in areas that may impact nontarget waters.

3. **An estuarine/marine fish early life-stage study (sheepshead minnow, preferred species; 71-4(a)):** Whether this study would be required depends on the results of the freshwater fish early life-stage study and comparisons with aquatic EECs.

4. **An estuarine/marine invertebrate life cycle study (mysid, preferred species; 71-4(b)):** Submission of this study would have a medium value since EFED does have a mysid life-cycle study (but one without an established NOEC) for use in characterizing chronic risks to estuarine/marine invertebrates. Submission of a new study would reduce uncertainty in the risk assessment. Further, the available chronic aquatic invertebrate data indicate adverse effects on reproduction and aquatic EECs (Texas and Mississippi) are

well above effect levels. In addition, the available data indicate: (1) tribufos is likely to be persistent in nontarget waters (hydrosoil) because the parent is stable to hydrolysis, photolysis, and aerobic soil metabolism; (2) tribufos has adverse effects on avian and mammalian reproduction (as well as on daphnid and mysid reproduction); and (3) tribufos is used in areas that may impact nontarget waters.

5. **Nontarget terrestrial plant studies (123-1(a) and (b))**: Submission of these studies would have a high value since EFED is unable to characterize risks to nontarget terrestrial plants. Tribufos is a defoliant that defoliates targeted plants. Further, it is applied aerially and is persistent in the environment. These factors provide for exposure of nontarget terrestrial plants.

6. **Nontarget aquatic plant studies (123-2)**: Vascular plants (*Lemna gibba*): Submission of this study would have a high value since EFED is unable to characterize risks to nontarget vascular plants. Submission of this study would reduce uncertainty in the risk assessment since it is not known how aquatic vascular plant species would respond to tribufos. Further, tribufos is applied aerially and is persistent in the environment. These factors provide for exposure of nontarget aquatic plants.

B. Environmental Fate and Ground Water

All environmental fate data requirements have been fully satisfied, except for Terrestrial Field Dissipation (164-1) and Spray Drift (201-1, 202-1).

- Two field dissipation studies were submitted and reviewed; however, both were found to be of questionable scientific validity. In addition, it was not clear what the route of dissipation was in the two studies. Both studies showed a rapid decline in residues, which cannot be explained, given the information provided by the laboratory studies. The laboratory studies show that tribufos is very stable to both chemical and microbial degradation. Other possible routes of dissipation, including accumulation in plants, volatilization, and leaching, are also not supported by the laboratory data. While it is not unusual to observe faster degradation in the field compared with the laboratory, the differences seen here were not justified.

  New studies are required to define the behavior of tribufos under actual field conditions.

- Spray Drift data requirements were imposed due to the phytotoxic nature of tribufos and its method of application. The registrant, Miles Inc., is a member of the Spray Drift Task Force, and may elect to satisfy these requirements through the Task Force.

V. Endangered Species

Endangered species LOCs are exceeded for birds (single and multiple applications), mammals (single and multiple applications), freshwater fish (Mississippi scenario), freshwater invertebrates (Texas and Mississippi scenarios), and estuarine/marine fish and invertebrates (Texas and Mississippi scenarios).

The Endangered Species Protection Program is expected to become final in the future. Limitations in the use of tribufos may be required to protect endangered and threatened species, but these limitations have not been defined and may be formulation specific. EPA anticipates that a consultation with the Fish and Wildlife Service may be conducted in accordance with the species-based priority approach described in the Program. After completion of consultation, registrants will be informed if any required label modifications are necessary. Such modifications would most likely consist of the generic label statement referring pesticide users to use limitations contained in county Bulletins.

VI. Risk Characterization

Tribufos is unique for several reasons: It is an organophosphate compound used as a defoliant (alone and tank mixed with other chemicals), it is unusually persistent, and it is applied in the fall.

According to information provided by BEAD, the use of tribufos has been rising from 1991 - 1994. In 1991, it was probably applied to more than 1 million acres, or <10% of planted acreage. In 1994, tribufos was applied to 4 million - 5 million acres, or about 30% - 35% of planted acreage. Usually, one application of tribufos is made at a rate of <1 lb ai/A; occasionally, two applications are made.

A major concern with tribufos is chronic risk because it is immobile and unusually persistent. However, EFED's assessment and characterization of the chronic risk from this chemical is incomplete. Crucial data are missing on field dissipation, freshwater and estuarine/marine fish early-life-stage toxicity, and toxicity to non-target plants. Tribufos is applied in the fall -- outside the breeding season for birds and aquatic species -- so the data are particularly important to understanding possible exposures to avian and aquatic species in the spring.

Though data are not available to support this, EFED believes that in some areas of the country, tribufos is applied mostly by aircraft. This is because the wheels of the ground equipment used to apply tribufos can damage the mature cotton plants and the wet soil may not be firm enough to support the equipment. The application method is important because some labels for tribufos already carry warnings to avoid contaminating surface water via aerial applications.

Mitigation measures for both acute and chronic risk are proposed below. Because of the low application rates for tribufos, it may not be possible to reduce or eliminate the risks and maintain an efficacious application level.

Based on information provided by HED, tribufos hits all of the triggers for special review based on health effects.

The following is a summary of risk for non-target organisms.

A. Avian Species

Acute Risks

Acute risks to nonendangered avian species are not likely; any potential acute risks may be mitigated by restricted use classification. For single, broadcast applications of nongranular products, risk quotients (RQs) ranged from 0.10 to 0.30. For multiple, broadcast applications of nongranular products, RQs ranged from 0.11 to 0.24.

Endangered avian species may be affected acutely, considering that such organisms may be more sensitive than nonendangered species. Further, the variation in acute oral LD50s and dietary LC50s appears to indicate a difference in sensitivity between species.

The certainty of the above assessment is moderate to high. The major factor that affects the certainty (and prevents it from being high) is the variation in response among different species in the acute oral and dietary studies. For example, in the dietary studies tribufos ranges from slightly toxic to moderately toxic to practically nontoxic depending on the species tested. This variation in response increases the uncertainty of the assessment.

Chronic Risks

Chronic risks are likely for avian species, including endangered species, for all use rates of tribufos, whether applied as a single application or as a multiple application (two applications of 0.75 lb ai/acre, applied 10 days apart). For single, broadcast applications of nongranular product, RQs ranged from 1.03 to 3.04. For multiple, broadcast applications of nongranular products, and assuming maximum expected environmental concentrations (EECs) from 164 ppm to 358 ppm, RQs ranged from 1.11 to 2.42. For multiple, broadcast applications of nongranular products, and assuming an average EEC of 196 ppm, the RQ was 1.32.

The certainty of the above assessment is low to moderate. Two factors that affect the certainty (preventing it from being higher) are: (1) the lack of a mallard duck reproduction study; and (2) application of tribufos in the fall, a time when birds are not typically breeding. However, the long persistence of tribufos in the environment (i.e., tribufos is stable to hydrolysis, photolysis, and aerobic soil metabolism; soil aerobic metabolism half-life = 745 days) tends to offset the second factor. These factors, therefore, lead to a conclusion that while the possibility of chronic risk exists, the probability of it occurring is difficult to assess.

B. Mammalian Species

Acute Risks

Considering the calculated RQs and the available mammalian toxicity database from HED, acute risks to small mammals, including endangered species, are likely. For single, broadcast applications of nongranular products, the RQs for herbivorous and insectivorous mammals on various food items ranged from 0.01 at an application rate of 0.75 lb ai/A to 2.23 for an application rate of 1.875 lb ai/A. For granivorous mammals, all acute RQs were $\leq$0.03. For multiple, broadcast applications of nongranular products totaling 1.50 lb ai/A, the RQs for herbivorous and insectivorous mammals on various food items ranged from 0.02 to 1.77. For granivorous mammals, all acute RQs were $\leq$0.02.

The certainty of this assessment is moderate to high. Two factors that affect this certainty and prevent it from being high are: (1) a small mammal acute dietary LC50 study, which could represent dietary effects of tribufos better than the acute oral rat LD50 study, is not available to develop an acute risk quotient; and (2) it is not known how sensitive wild mammals may be to tribufos.

Chronic Risks

Chronic risks are likely for mammalian species, including endangered species, for single and multiple applications of tribufos. Several exposure scenarios were examined, including a 21-day exposure period, which should cover the shortest gestation period for a representative small mammal such as the white-footed mouse, *Peromyscus leucopus*. Even under this scenario, and using average estimated residues, chronic risk quotients were exceeded (RQs ranged from 6.38-13.94).

The certainty of the above assessment is high because:

1. The available chronic mammalian data appear to be scientifically-sound and provide values (NOEC and LOEC) related to effects on reproductive parameters (significant increase in dead pups in F1a and F2a litters).

2. Tribufos persists in the environment, allowing for chronic exposure of mammalian species.

C. Insects

EFED has no procedures for assessing risk to nontarget insects. Results of acceptable studies are used for recommending appropriate labeling precautions.

D. Aquatic Species

These assessments are based on exposure scenarios from three states: California, representing a dry climate; Mississippi, representing a wet climate; and Texas, a mixed climate.

a) California

1. Acute risks to freshwater vertebrates and invertebrates, including endangered species, are not likely.

2. A chronic risk characterization for freshwater fish is not possible; chronic effects data are lacking. However, chronic risks for freshwater invertebrates, including endangered species, are unlikely.

3. Use of tribufos in California is not expected to impact estuarine/marine environments. Acute and chronic risks to estuarine/marine vertebrates and invertebrates, including endangered species, are not likely.

b) Texas

1. Acute risks to freshwater vertebrates, including endangered species, are not likely from use of tribufos in Texas. However, a chronic risk characterization for freshwater fish is not possible; chronic effects data are lacking.

2. Acute risks to freshwater invertebrates may be mitigated by restricted use classification; however, chronic risks to these organisms is likely. Endangered freshwater invertebrates are likely to be affected acutely and chronically.

3. Acute risks to nonendangered estuarine/marine fish are not likely; however, endangered estuarine/marine fish may be affected acutely. A chronic risk characterization for estuarine/marine fish is not possible; chronic effects data are lacking.

4. Acute and chronic risks to estuarine/marine invertebrates, including endangered species, are likely.

b) Mississippi

1. Endangered freshwater fish may be acutely affected. However, a chronic risk characterization for freshwater fish is not possible; chronic effects data are lacking.

2. Acute risks to estuarine/marine fish may be mitigated by restricted use classification. However, endangered fish may be affected acutely. A chronic risk characterization for estuarine/marine fish is not possible; chronic effects data are lacking.

3. Acute and chronic risks to freshwater and estuarine/marine invertebrates, including endangered species, are likely.

The certainty of the acute risk assessment is moderate to high. The available fish toxicity data are fairly consistent, ranging from moderately toxic to highly toxic. However, the available aquatic invertebrate toxicity data are more variable, ranging from moderately toxic to very highly toxic. This variation in response indicates differences in sensitivity between species and increases the uncertainty of the assessment preventing it from being high.

The certainty of the chronic risk assessment is moderate to high because:

1. The available chronic aquatic data appear to be scientifically-sound and provide values (NOEC and LOEC) related to effects on reproductive parameters. (Although a NOEC was not determined in the mysid life-cycle study, use of the LOEC in developing RQs still resulted in values well above the LOC of 1.0.)

2. Tribufos is likely to persist in the aquatic environment (hydrosoil) allowing for chronic exposure of aquatic species.

3. However, the absence of chronic fish studies affects the certainty and prevents it from being high.

E. Plants

The risks to nontarget terrestrial and semi-aquatic plants and to aquatic vascular plants cannot be assessed because pertinent plant studies are lacking. For aquatic nonvascular plants, risks are minimal, both for nonendangered and endangered plants. At an application rate of 1.875 lb ai/A, RQs for both plant types ranged from 0.0003-0.014.

The certainty of the risk assessment for plants is low because of the lack of pertinent terrestrial and aquatic plant data.

VII. Risk Reduction Measures

Because of the low application rates for tribufos, it may not be possible to reduce or eliminate the risks and maintain an efficacious application level.

Acute high risks appear greatest for nontarget mammals (herbivores/insectivores) and aquatic invertebrates exposed to tribufos residues. To mitigate such risks, the following are recommended:

1. Reduce rates of application wherever possible;
2. Limit use to ground sprayer applications; and
3. Restrict use to certified applicators.

Chronic risks are likely for birds, mammals, and aquatic organisms exposed to tribufos residues. However, because of the persistence of tribufos, it is difficult to determine what mitigation measures could reduce such risks. The recommendations for acute risks could be used, but it is doubtful they would eliminate chronic risks.

At this time, EFED is not recommending that monitoring of surface water drinking supply systems for tribufos or its major degradate, 1-butane sulfonic acid, be required for reregistration because:

1. Tribufos is not currently regulated under the Safe Drinking Water Act, so no MCL has been established for it and water supplies are not required to sample and analyze for it.

2. The Office of Drinking Water has not established any Health Advisory Levels (HALs) for it.

3. The relatively high soil/water partitioning of tribufos indicates that the primary treatment processes employed by most surface water supply systems to remove suspended particulates should be relatively effective in removing tribufos.

4. Neither tribufos nor 1-butane sulfonic acid are on HED's list of "Apparent Exceeders (Chronic Effects and Cancer)" contained in their report, "Pesticides Appearing to Pose Excessive Dietary Risk."

VIII. Labeling

Manufacturing Use Products

The following label statements are recommended for manufacturing use products:

This product is toxic to fish and aquatic invertebrates. Do not discharge effluent containing this product into lakes, streams, ponds, estuaries, oceans, or public water unless this product is specifically identified and addressed in an

NPDES permit. Do not discharge effluent containing this product to sewer systems without previously notifying the sewage treatment plant authority. For guidance contact your State Water Board of Regional Office of the EPA.

End-Use Products

The following label statements are recommended for end-use products:

This product is toxic to fish and aquatic invertebrates. Do not apply directly to water, or to areas where surface water is present or to intertidal areas below the mean high water mark.

Surface-Water Advisory

If a decision is made to include on the label wording to minimize runoff, EFGWB recommends the following wording:

Tribufos can contaminate surface water through spray drift. Under some conditions, tribufos may also have a high potential for runoff into surface water (primarily via adsorption to eroding soil), for several months post-application. These include poorly draining or wet soils with readily visible slopes toward adjacent surface waters, frequently flooded areas, areas overlaying extremely shallow ground water, areas with in-field canals or ditches that drain to surface water, areas not separated from adjacent surface waters with vegetated filter strips, and highly erodible soils cultivated using poor agricultural practices such as conventional tillage and down the slope plowing.

Drinking Water Exposure:

Tier II Estimated Environmental Concentrations (EECs) for use in the human health risk assessment were calculated using PRZM2 and EXAMS II. A Tier II EEC assessment uses a single site which represents a high-end exposure scenario from pesticide use on a particular crop or non-crop use site. The meteorology and agricultural practice are simulated at the site for 36 years so that the probability of an EEC occurring at that site can be estimated.

PRZM2 simulates erosion and runoff from an agricultural field and EXAMS II simulates the fate in a surface water body. It was assumed that 5 percent of the applied tribufos reached the surface water via aerial spray drift at the time of application and that 95% of the applied chemical was deposited on the target site.

An aerial application of 1.875 lbs ai/acre liquid formulation to cotton in Mississippi was modeled. Tier II upper tenth percentile EECs are 0.014 ppm (acute - peak) and 0.005 ppm (chronic - 60 day). The EECs have been calculated so that in any given year, there is a 10% probability that the maximum average concentration of that duration in that year will equal or exceed the EEC at the site.

A quantitative assessment for ground water was not completed because tribufos, based on its environmental characteristics, is not expected to reach ground water.

Environmental Fate and Effects Risk Assessment for Tribufos

1. Ecological Toxicity Data

a. Toxicity to Terrestrial Animals

i. Birds, Acute and Subacute

An acute oral toxicity study using the technical grade of the active ingredient (TGAI) is required to establish the toxicity of tribufos to birds. The preferred test species is either mallard duck (a waterfowl) or bobwhite quail (an upland gamebird). Results of this test are tabulated below.

Table . Avian Acute Oral Toxicity

Species	% ai	LD50 (mg/kg)	Toxicity Category	MRID No. Author/Year	Study Classification
Pheasant	92%	273 (F)	moderately toxic	160000 Hudson, R.H. et al., 1984	core
Mallard	92%	2,934 (M)	practically nontoxic	160000 Hudson, R.H. et al., 1984	core
Northern bobwhite quail *(Colinus virginianus)*	92.0	151	moderately toxic	00049258 Lamb, D.W. and R.E. Jones, 1972	core
Mallard duck *(Anas platyrhynchus)*	92.0	871	slightly toxic	00049258 Lamb, D.W. and R.E. Jones, 1972	supplemental

These results indicate that tribufos ranges from practically nontoxic to moderately toxic to avian species on an acute oral basis. The guideline requirement (71-1) is fulfilled (MRIDs 00049258 and 160000). The mallard duck study did not fulfill the guideline requirement in support of reregistration because 8 birds were used instead of ten per dose level and no food consumption data were provided (MRID 00049258).

Two subacute dietary studies using the technical grade of the active ingredient are required to establish the toxicity of a pesticide to birds. The preferred test species are mallard duck (a waterfowl) and bobwhite quail (an upland gamebird). Results of these tests are tabulated below.

Table . Avian Subacute Dietary Toxicity

Species	% ai	LC50 (ppm)	Toxicity Category	MRID No. Author/Year	Study Classification
Northern bobwhite quail *(Colinus virginianus)*	98.9	1519	slightly toxic	41618804 Grau, R.,1990	core
Mallard duck *(Anas platyrhynchus)*	99.8	>5000	practically nontoxic	41618805 Grau, R., 1990	core

These results indicate that tribufos is slightly toxic to practically nontoxic to avian species on a subacute dietary basis. The guideline requirement (71-2) is fulfilled (MRIDs 41618804 and 41618805).

ii. Birds, Chronic

Avian reproduction studies using the TGAI are required for tribufos because the following conditions are met: (1) birds may be subject to repeated or continuous exposure to the pesticide, especially preceding or during the breeding season, (2) the pesticide is stable in the environment to the extent that potentially toxic amounts may persist in animal feed, (3) the pesticide is stored or accumulated in plant or animal tissues, and/or, (4) information derived from mammalian reproduction studies indicates reproduction in terrestrial vertebrates may be adversely affected by the anticipated use of the product. The preferred test species are mallard duck and bobwhite quail. Results of these tests are tabulated below.

Table . Avian Reproduction

Species	% ai	NOEC/LOEC (ppm)	Endpoints Affected	MRID No. Author/Year	Study Classification
Northern bobwhite quail *(Colinus virginianus)*	98.7	NOEC = 148 ppm ai LOEC = 262 ppm ai (mean measured concentrations)	egg shell thickness decreased	40757101, Beavers, J.B, et al., 1988	core

The bobwhite quail reproduction study included a control plus three test levels of 150, 280, and 410 ppm nominal concentrations. Mean measured concentrations for these levels were 148, 262, and 392 ppm ai, respectively. Egg production, survival of hatchlings, and body weight of the 14-day survivors were decreased in the 392 ppm ai group. At 262 ppm ai, there was a significant decrease in egg shell thickness. The 148 ppm ai level did not result in treatment related mortality, signs of toxicity, or effects on reproductive parameters. The NOEC and LOEC for this study are 148 and 262 ppm ai, respectively. The guideline requirement (71-4) is partially fulfilled (MRID 40757101). Another avian reproduction study using mallard duck is required for tribufos because: (1) adverse effects were observed in the bobwhite quail reproduction study; (2) tribufos has adverse effects on mammalian and aquatic invertebrate reproduction; and (3) tribufos is persistent and likely to be found on avian food items during the breeding season. (Although tribufos is applied in the fall, residues are likely to occur the following spring because of the parent compound's persistence in the environment; i.e., aerobic soil half-life = 745 days.)

iii. Mammals, Acute and Chronic

Wild mammal testing is required on a case-by-case basis, depending on the results of lower tier laboratory mammalian studies, intended use pattern and pertinent environmental fate characteristics. In most cases, rat or mouse toxicity values obtained from the Agency's Health Effects Division (HED) substitute for wild mammal testing. These toxicity values are reported below.

Table . Mammalian Toxicity

Species	% ai	Test Type	Toxicity Values	MRID No.
laboratory rat (*Rattus norvegicus*)	98.0	2-generation reproduction	Rats dosed at 4, 32, and 260 ppm. Only compound-related effect on reproduction was a significant increase in dead pups in $F1_a$ and $F2_a$ litters. NOEC = 32 ppm; LOEC = 260 ppm.	42040101
laboratory rat (*Rattus norvegicus*)	98.1	acute oral	LD_{50} between 192 and 235 mg/kg for both sexes.	41954903

The results indicate that tribufos is moderately toxic to small mammals on an acute oral basis. On a chronic basis, the NOEC in a two-generation reproduction study was 32 ppm.

iv. Insects

A honey bee acute contact study using the TGAI is required for tribufos because its use on blooming cotton will result in honey bee exposure. Results of this test are tabulated below.

Nontarget Insect Acute Contact Toxicity

Species	% ai	LD50 (μg/bee)	Toxicity Category	MRID No. Author/Year	Study Classification
Honey bee *(Apis mellifera)*	technical	> 24.17	practically nontoxic	00001999 Atkins, E. L. and L. D. Anderson, 1967	core

The results indicate that tribufos is practically nontoxic to bees on an acute contact basis. The guideline (141-1) is fulfilled (MRID 00001999).

A honey bee toxicity of residues on foliage study using the typical end-use product is not required for tribufos because it is practically nontoxic to bees.

v. Terrestrial Field Testing

Terrestrial field testing data are not available for tribufos.

b. Toxicity to Freshwater Aquatic Animals

i. Freshwater Fish, Acute

Two freshwater fish toxicity studies using the TGAI are required to establish the toxicity of tribufos to fish. The preferred test species are rainbow trout (a coldwater fish) and bluegill sunfish (a warmwater fish). Results of these tests are tabulated below.

Table . Freshwater Fish Acute Toxicity

Species	% ai	LC50 (ppm)	Toxicity Category	MRID No. Author/Year	Study Classification
Bluegill sunfish (*Lepomis macrochirus*)	95%	0.620	highly toxic	40094602 Johnson, W. and M. Finley, 1980	core
Rainbow trout *(Oncorhynchus mykiss)*	95%	0.660	highly toxic	400994602 Johnson, W. and M. Finley, 1980	core
Rainbow trout *(Oncorhynchus mykiss)*	96.2	1.700	moderately toxic	41618808 Grau, R., 1990	supplemental
Bluegill sunfish (*Lepomis macrochirus*)	96.2	0.630	highly toxic	41618806 Grau, R., 1990	core
Rainbow trout *(Oncorhynchus mykiss)*	72.3	0.608	highly toxic	41618807 Grau, R., 1990	core
Rainbow trout *(Oncorhynchus mykiss)*	95	0.660	highly toxic	40098001 F. L. Mayer and M. R. Ellersieck, 1986	core
Rainbow trout *(Oncorhynchus mykiss)*	95	1.000	highly toxic	40098001 F. L. Mayer and M. R. Ellersieck, 1986	core
Rainbow trout *(Oncorhynchus mykiss)*	72	0.780	highly toxic	40098001 F. L. Mayer and M. R. Ellersieck, 1986	core
Rainbow trout *(Oncorhynchus mykiss)*	95	1.700	moderately toxic	40098001 F. L. Mayer and M. R. Ellersieck, 1986	core
Rainbow trout *(Oncorhynchus mykiss)*	95	1.300	moderately toxic	40098001 F. L. Mayer and M. R. Ellersieck, 1986	core
Rainbow trout *(Oncorhynchus mykiss)*	95	0.830	highly toxic	40098001 F. L. Mayer and M. R. Ellersieck, 1986	core
Rainbow trout *(Oncorhynchus mykiss)*	95	1.450	moderately	40098001 F. L. Mayer and M. R. Ellersieck, 1986	core
Rainbow trout *(Oncorhynchus mykiss)*	95	1.000	highly toxic	40098001 F. L. Mayer and M. R. Ellersieck, 1986	core
Rainbow trout *(Oncorhynchus mykiss)*	95	0.750	highly toxic	40098001, F. L. Mayer and M. R. Ellersieck, 1986	core
Rainbow trout *(Oncorhynchuso mykiss)*	95	1.700	moderately toxic	40098001 F. L. Mayer and M. R. Ellersieck, 1986	core
Rainbow trout *(Oncorhynchuso mykiss)*	95	1.800	moderately toxic	40098001 F. L. Mayer and M. R. Ellersieck, 1986	core
Channel Catfish *(Ictalurus punctatus*)	95	0.350	highly toxic	40098001 F. L. Mayer and M.R. Ellensieck, 1986	core

Table . Freshwater Fish Acute Toxicity

Species	% ai	LC50 (ppm)	Toxicity Category	MRID No. Author/Year	Study Classification
Channel Catfish *(Ictalurus punctatus*)	95	1.540	moderately toxic	40098001 F. L. Mayer and M.R. Ellensieck, 1986	core
Bluegill sunfish (*Lepomis macrochirus*)	95	0.620	highly toxic	40098001 F. L. Mayer and M. R. Ellerseick, 1986	core
Bluegill sunfish (*Lepomis macrochirus*)	95	0.570	highly toxic	40098001 F. L. Mayer and M. R. Ellerseick, 1986	core
Bluegill sunfish (*Lepomis macrochirus*)	95	0.520	highly toxic	40098001 F. L. Myer and M. R. Ellerseick, 1986	core
Bluegill sunfish (*Lepomis macrochirus*)	95	1.300	moderately toxic	40098001 F. L. Myer and M. R. Ellerseick, 1986	core
Bluegill sunfish (*Lepomis macrochirus*)	95	0.740	highly toxic	40098001 F. L. Myer and M. R. Ellerseick, 1986	core
Bluegill sunfish (*Lepomis macrochirus*)	95	0.540	highly toxic	40098001 F. L. Myer and M. R. Ellerseick, 1986	core
Bluegill sunfish (*Lepomis macrochirus*)	95	0.640	moderately toxic	40098001 F. L. Myer and M. R. Ellerseick, 1986	core
Bluegill sunfish (*Lepomis macrochirus*)	95	0.640	highly toxic	40098001 F. L. Myer and M. R. Ellerseick, 1986	core
Bluegill sunfish (*Lepomis macrochirus*)	95	0.780	highly toxic	40098001 F. L. Myer and M. R. Ellerseick, 1986	core
Bluegill sunfish (*Lepomis macrochirus*)	95	0.245	highly toxic	40098001 F. L. Myer and M. R. Ellerseick, 1986	core
Bluegill sunfish (*Lepomis macrochirus*)	95	0.270	highly toxic	40098001 F. L. Myer and M. R. Ellerseick, 1986	core

These results indicate that tribufos is moderately to highly toxic to freshwater fish on an acute basis. The guideline requirement (72-1) is fulfilled (MRIDs 40094602, 40098001, 41618808, and 41618806). The rainbow study is classified supplemental because: (1) surface film and precipitates were observed in all test concentrations except the lowest; (2) samples were not filtered before chemical analysis; and (3) there was high variation among measured concentrations (MRID 41618808).

ii. Freshwater Fish, Chronic

A freshwater fish early life-stage test using the TGAI is required for tribufos because the end-use product may be applied directly to water or is expected to be transported to water from the intended use site, and the following conditions are met: (1) the pesticide is intended for use such that its presence in water is likely to be continuous or recurrent regardless of toxicity, (2) any aquatic acute LC50 or EC50 is less than 1 mg/l, (3) the EEC in water is equal to or greater than 0.01 of any acute LC50 or EC50 value, or, (4) the actual or estimated environmental concentration in water resulting from use is less than 0.01 of any acute LC50 or EC50 value and any one of the following conditions exist: studies of other organisms indicate the reproductive physiology of fish may be affected, physicochemical properties indicate cumulative effects, or the pesticide is persistent in water (e.g., half-life greater than 4 days). The preferred test species is rainbow trout.

A freshwater fish early life-stage test using tribufos is not available at this time. This study is required as confirmatory data based on the following: (1) tribufos is likely to be persistent in nontarget waters (hydrosoil) because the parent is stable to hydrolysis, photolysis, and aerobic soil metabolism; (2) aquatic EECs are greater than 0.01 of the bluegill sunfish LC50 value of 0.245 ppm for the Mississippi and Texas scenarios; (3) tribufos has adverse effects on avian, mammalian, and aquatic invertebrate reproduction; and (4) tribufos may be used in areas that may impact nontarget waters, as evidenced by the aquatic EEC calculations. The guideline (72-4) is not fulfilled.

A freshwater fish life-cycle test using the TGAI of tribufos is not required at this time.

iii. Freshwater Invertebrates, Acute

A freshwater aquatic invertebrate toxicity test using the TGAI is required to establish the toxicity of tribufos to aquatic invertebrates. The preferred test species is *Daphnia magna*. Results of this test are tabulated below.

Table . Freshwater Invertebrate Toxicity

Species	% ai	LC50/ EC50 (ppm)	Toxicity Category	MRID No. Author/Year	Study Classification
Daphnid (*Daphnia magna*)	98.7	0.110	highly toxic	41689901 Heimbach, F., 1989	core
Daphnid (*Daphnia magna*)	72.3	0.061	very highly toxic	41689902 Heimbach, F., 1989	core
Daphnid (*Daphnia magna*)	95	0.007	very highly toxic	40098001 F. L. Myer and M. R. Ellersieck, 1986	core
Scud (*Gammarus fasciatus*)	95	0.100	highly toxic	40098001 F. L. Myer and M. R. Ellersieck, 1986	core
Scud (*Gammarus pseudolimnaeus*)	95	0.027	very highly toxic	40098001 F. L. Mayer and M. R. Ellersieck, 1986	core
Crayfish (*Orconectes nais*)	95	> 5.600	moderately toxic	40098001 F. L. Mayer and M. R. Ellersieck, 1986	supplemental
Stonefly (*Pteronarcys california*)	95	2.100	moderately toxic	40098001 F. L. Mayer and M. R. Ellersieck, 1986	core
Midge (*Chironomus plumosus*)	95	0.040	very highly toxic	40098001 F. L. Mayer and M. R. Ellersieck, 1986	core

The results indicate that tribufos is moderately to very highly toxic to aquatic invertebrates on an acute basis. The guideline requirement (72-2) is fulfilled (MRIDs 41689901, 41689902, and 40098001). The crayfish study is classified supplemental because 95% confidence limits were not established (MRID 40098001).

iv. Freshwater Invertebrate, Chronic

A freshwater aquatic invertebrate life-cycle test using the TGAI is required for tribufos for the same reasons detailed in the above section, "Freshwater Fish, Chronic." The preferred test species is *Daphnia magna*. Results of this test are tabulated below.

Freshwater Aquatic Invertebrate Life-Cycle Toxicity

Species/Static Renewal or Flow-through)	% ai	21-day NOEC/LOEC (ppm)	MATC[1] (ppm)	Endpoints Affected	MRID No. Author/Year	Study Classification
Waterflea *(Daphnia magna)* (Static Renewal)	97.2	NOEC = 0.00156 LOEC = 0.00323	0.00224	Reproduction (No. offspring) and length - most sensitive endpoints	43978201 Bowers, L. M., 1996	core

[1] defined as the geometric mean of the NOEC and LOEC.

Daphnids were exposed to levels of 0.35, 0.77, 1.56, 3.23, and 6.60 ug/L mean measured concentrations for 21 days under static renewal conditions. NOECs for survival, reproduction, adult length, and adult weight are 6.60, 1.56, 1.56, and 3.23 ug/L mean measured concentrations, respectively. LOECs for survival, reproduction, adult length, and adult weight are > 6.60, 3.23, 3.23, and 6.60 ug/L mean measured concentrations, respectively. MATCs for reproduction, adult length, and adult weight are 2.24, 2.24, and 4.62 ug/L mean measured concentrations, respectively. The guideline (72-4) is fulfilled (MRID 43978201).

v. Freshwater Field Studies

No freshwater field testing is available for tribufos.

c. Toxicity to Estuarine and Marine Animals

i. Estuarine and Marine Fish, Acute

Acute toxicity testing with estuarine/marine fish using the TGAI is required for tribufos because the end-use product is intended for direct application to the marine/estuarine environment or the active ingredient is expected to reach this environment because of its use in coastal counties. The preferred test species is sheepshead minnow. Results of these tests are tabulated below.

Table . Estuarine/Marine Fish Acute Toxicity

Species	% ai	LC50 (ppm)	Toxicity Category	MRID No. Author/Year	Study Classification
Sheepshead minnow *(Cyprinodon variegatus)*	95	0.440	highly toxic	40228401 Mayer, F. L., 1986	core
Sheepshead minnow *(Cyprinodon variegatus)*	95	> 0.440	highly toxic	40228401 Mayer, F. L., 1986	supplemental
Pinfish *(Lagodon rhomboides)*	95	0.290	highly toxic	40228401 Mayer, F. L., 1986	core
Spot *(Leiostomus xanthurus)*	95	0.240	highly toxic	40228401 Mayer, F. L., 1986	supplemental
Spot *(Leiostomus xanthurus)*	95	0.160	highly toxic	40228401 Mayer, F. L., 1986	core
Spot *(Leiostomus xanthurus)*	95	0.130	highly toxic	40228401 Mayer, F. L., 1986	core
Sheepshead minnow *(Cyprinodon variegatus)*	98.6	0.767	highly toxic	41896302 Gagliamo, G. G., 1991	core

The results indicate that tribufos is highly toxic to estuarine/marine fish on an acute basis. Those studies classified supplemental did not establish 95% confidence limits. The guideline (72-3a) is fulfilled (MRIDs 40228401 and 41896302).

ii. Estuarine and Marine Fish, Chronic

An estuarine/marine fish early life-stage toxicity test using the TGAI is required for tribufos for the same reasons detailed in the above section, "Freshwater Fish, Chronic." The preferred test species is sheepshead minnow.

An estuarine/marine fish early life-stage toxicity test is not available for tribufos at this time. This requirement (72-4) depends on the results of other chronic aquatic studies (i.e., the freshwater fish early life-stage toxicity test).

An estuarine/marine fish life-cycle test using the TGAI of tribufos is not required at this time.

iii. Estuarine and Marine Invertebrates, Acute

Acute toxicity testing with estuarine/marine invertebrates using the TGAI is required for tribufos because the end-use product is intended for direct application to the marine/estuarine environment or the active ingredient is expected to reach this environment because of its use in coastal counties. The preferred test species are mysid shrimp and eastern oyster. Results of these tests are tabulated below.

Table . Estuarine/Marine Invertebrate Acute Toxicity

Species	% ai	LC50 (ppm)	Toxicity Category	MRID No.	Status
Eastern oyster (shell deposition *(Crassostrea virginica)*	96.4	0.040	very highly toxic	42083201 Wheat, J. V. and G.S. Ward, 1991	core
Eastern oyster *(Crassostrea virginica)*	95	0.200	highly toxic	40228401 Mayer, F. L., 1986	core
Mysid (*Americamysis bahia)*	95	0.006	very highly toxic	40228401 Mayer, F. L., 1986	core
Mysid (*Americamysis bahia)*	95	0.005	very highly toxic	40228401 Mayer, F. L., 1986	core
Brown Shrimp (*Penaeus aztecus*)	95	0.028	very highly toxic	40228401 Mayer, F. L., 1986	supplemental
White shrimp (*Penaeus stylirostris*)	95	0.025	very highly toxic	40228401 Mayer, F. L., 1986	core
Eastern oyster (*Crassostrea virginica*)	95	0.210	highly toxic	40228401 Mayer, F. L., 1986	supplemental
Eastern oyster (*Crassostrea virginica*)	95	0.100	highly toxic	40228401 Mayer, F. L., 1986	supplemental
Grass Shrimp (*Palaemonetes pugio*)	95	0.022	very highly toxic	40228401 Mayer, F. L., 1986	core
Pink Shrimp (*Panaeus duorarum*)	95	0.014	very highly toxic	40228401 Mayer, F. L., 1986	core
Mysid (*Americamysis bahia*)	96.4	0.012	very highly toxic	41896301 Ward, S. G., 1991	core

The results indicate that tribufos is highly to very highly toxic to estuarine/marine invertebrates on an acute basis. The guideline requirement (72-3(b) and 72-3(c)) is fulfilled (MRIDs 42083201, 40228401, and 41896301). Those studies classified supplemental did not establish 95% confidence limits.

iv. Estuarine and Marine Invertebrates, Chronic

An estuarine/marine invertebrate life-cycle toxicity test using the TGAI is required for TGAI for the same reasons detailed in the above section, "Freshwater Fish, Chronic." The preferred test species is mysid shrimp. Results of this test are tabulated below.

Estuarine/Marine Invertebrate Life-Cycle Toxicity

Species/(Static Renewal or Flow-through)	% ai	21-day NOEC/LOEC (ppm)	MATC[1] (ppm)	Endpoints Affected	MRID No. Author/Year	Study Classification
Mysid *(Americamysis bahia)* (flow-through)	95	NOEC = < 0.00034 LOEC = 0.00034	Not determined	No. of offspring	EPA-600/4-81-023 USEPA, 1981	supplemental

[1] defined as the geometric mean of the NOEC and LOEC.

Mysid shrimp were exposed to 0.34, 0.68, 1.70, and 3.30 ug/L mean measured concentrations in a flow-through system. The number of offspring per female was significantly reduced (at least 50 %) at all concentrations. A NOEC and MATC were not determined; the LOEC was 0.34 ug/L. The guideline (72-4) is partially fulfilled (MRID EPA-600-4-81-023). Another estuarine/marine invertebrate toxicity study is required as confirmatory data based on the following: (1) tribufos is likely to be persistent in nontarget waters (hydrosoil) because the parent is stable to hydrolysis, photolysis, and aerobic soil metabolism; (2) aquatic EECs are greater than 0.01 of the mysid shrimp LC50 value of 0.005 ppm for the Mississippi and Texas scenarios; (3) chronic risk quotients, using the chronic LOEC of 0.0003 ppm for mysid shrimp, are high ($\geq$ 10) for Mississippi and Texas; (4) tribufos has adverse effects on avian, mammalian, and aquatic invertebrate reproduction; and (5) tribufos may be used in areas that may impact nontarget waters, as evidenced by the aquatic EEC calculations.

d. Toxicity to Plants

i. Terrestrial

Terrestrial plant testing (seedling emergence and vegetative vigor) is required for herbicides that have terrestrial non-residential outdoor use patterns and that may move off the application site through volatilization (vapor pressure $\geq$1.0 x 10^{-5}mm Hg at 25^{o}C) or drift (aerial or irrigation) and/or that may have endangered or threatened plant species associated with the application site.

Currently, terrestrial plant testing is not required for pesticides other than herbicides except on a case-by-case basis (e.g., labeling bears phytotoxicity warnings incident data or literature that demonstrate phytotoxicity).

For seedling emergence and vegetative vigor testing the following plant species and groups should be tested: (1) six species of at least four dicotyledonous families, one species of which is soybean (*Glycine max*), and the second of which is a root crop, and (2) four species of at least two monocotyledonous families, one of which is corn (*Zea mays*).

Terrestrial Tier II studies are required for all low dose herbicides (those with the maximum use rate of 0.5 lbs ai/A or less) and any pesticide showing a negative response equal to or greater than 25% in Tier I tests. Tier II tests measure the response of plants, relative to a control, at five or more test concentrations.

Terrestrial plant data are not available for tribufos at this time. Terrestrial tier II studies (123-1 and 123-2) are required for tribufos because this compound is a cotton defoliant. Other nontarget plants could be similarly affected via spray drift. Further, tribufos is persistent in the terrestrial and aquatic (hydrosoil) environment. The guideline (123-1) is not fulfilled.

ii. Aquatic Plants

Aquatic plant testing is required for any herbicide that has outdoor non-residential terrestrial uses that may move off-site by runoff (solubility >10 ppm in water), by drift (aerial or irrigation), or that is applied directly to aquatic use sites (except residential). Aquatic Tier II studies are required for all low dose herbicides (those with the maximum use rate of 0.5 lbs ai/A or less) and any pesticide showing a negative response equal to or greater than 50% in Tier I tests. The following species should be tested at Tier II: *Kirchneria subcapitata*, *Lemna gibba*, *Skeletonema costatum*, *Anabaena flos-aquae*, and a freshwater diatom. Results of Tier II toxicity testing on the technical/TEP material are tabulated below.

Nontarget Aquatic Plant Toxicity (Tier II)

Species	% ai	EC50/ NOEC (ppm)	MRID No. Author/Year	Study Classification
Green algae *Kirchneria subcapitata*	99.9	EC50 = 0.148 NOEC = 0.118	41618813 Hughes, J. S., 1990	core
Marine diatom *Skeletonema costatum*	95	EC50 = 0.370 (NOEC not determined)	40228401 Mayer, F. L., 1986	core

The Tier II results, based on two nonvascular aquatic plants, indicate that the green algae is more sensitive than the marine diatom. The guideline (123-2) is partially fulfilled (MRIDs 41618813 and 40228401). The following study is required for guideline 123-2 to be fulfilled: vascular plant (duckweed, *Lemna gibba*). This study is required because tribufos may drift, via aerial application, to nontarget waters; also, tribufos is persistent in water (hydrosoil).

2. Environmental Fate

a. Environmental Fate and Transport Assessment

The environmental fate of tribufos has been well characterized in the laboratory. However, its behavior in the field is not yet clearly understood, though based on the laboratory data, it appears that tribufos could accumulate in soil with repeated applications. The primary route of dissipation appears to be metabolism in flooded soil under anaerobic conditions, with a half-life of 4-6 months. In general, tribufos may be described as a persistent and immobile compound. It is also only moderately soluble with an aqueous solubility of 2.3 ppm. As such, ground water contamination and surface water contamination through dissolved runoff are not expected. Tribufos can contaminate surface water at application by spray drift. Substantial fractions of applied tribufos may remain available for runoff for many months post-application. The relatively high soil/water partitioning of tribufos indicates that runoff will generally occur primarily via adsorption to eroding soil as oppossed to dissolution in runoff water. In addition, the concentration of tribufos adsorbed to suspended and bottom sediment will be much greater than its concentration in sediment pore water or the water column.

Persistence

Tribufos does not undergo hydrolysis in sterile aqueous solutions of pH 5 and 7, and hydrolyzes slowly in sterile aqueous solutions of pH 9. Tribufos does not photodegrade in water or on soil. It is also persistent in aerobic soil with an estimated half-life of 745 days. Under anaerobic (N_2) conditions, tribufos degraded with a calculated half-life of 389 days in soil. The primary route of dissipation appears to be metabolism in flooded soil under anaerobic conditions, with a half-life of 4-6 months.

Mobility

Tribufos can be characterized as being immobile in soil. Freundlich K_{ads} values ranged from 61-106 in sand, sandy loam, silt loam, and clay loam soils. K_{oc}'s ranged from 4870-12684. Aged tribufos residues were also not mobile, with 90-99% of the applied remaining in the 0-6 cm layer of the soil columns.

Field Data

The terrestrial field dissipation studies submitted to date have been of little value in helping to assess the behavior of tribufos in the field. The studies were found to be unacceptable for several reasons including; a) the route of dissipation was not defined in either study, b) only 29% of the applied tribufos was accounted for immediately after treatment in the Georgia study, and c) the concentration of tribufos in the 0-6 inch soil depth immediately postapplication varied by more than 10x in the California study.

It was not clear what the route of dissipation was in the two studies. Both studies showed a rapid decline in residues, which cannot be explained, given the information provided by the laboratory studies. The laboratory studies show that tribufos is very stable to both chemical and microbial degradation. Other possible routes of dissipation, including accumulation in plants, volatilization, and leaching, are also not supported by the laboratory data. While it is not unusual to observe faster degradation in the field compared with the laboratory, the differences seen here were not justified.

Accumulation

Fish accumulation data have shown that tribufos has a low potential to bioconcentrate in bluegill sunfish. Bioconcentration factors were 300X, 1300X, and 730X for edible tissues, nonedible tissues, and whole fish, respectively. Tissue residues decreased rapidly during the depuration period with 71-88% of the radioactivity eliminated after 14 days.

b. Surface Water Assessment

Tribufos can contaminate surface water at application by spray drift. Substantial fractions of applied tribufos may remain available for runoff for many months post-application (aerobic soil metabolism half-life of 745 days). The relatively high soil/water partitioning of tribufos (Freundlich K_{ads} values of 67, 61, 74, and 106; K_{oc} values of 12700, 10500, 4900, and 9100) indicates that runoff will generally occur primarily via adsorption to eroding soil as opposed to dissolution in runoff water.

Tribufos is stable to abiotic hydrolysis at pHs 5 and 7, stable to direct aqueous photolysis, has a relatively low volatilization potential, undergoes slow abiotic hydrolysis at pH 9 and appears to undergo extremely slow biodegradation under aerobic conditions. Consequently, tribufos will probably be persistent in the water column of most surface waters except those with short hydrologic residence times for which flow out of the system may be the major dissipation pathway. The results of the anaerobic soil metabolism study and the anaerobic aquatic metabolism study indicate that tribufos may be a little less persistent under the anaerobic conditions found in most sediments, but that it will still be relatively persistent. The relatively high soil/water partitioning of tribufos indicates that its concentration adsorbed to suspended and bottom sediment will be much greater than its concentration in sediment pore water or the water column. Tribufos has a relatively low bioaccumulation potential as indicated by BCF values generally <1000X and a maximum BCF of 1300X for the bluegill sunfish.

The only major degradate of tribufos appears to be 1-butane sulfonic acid which was detected at a maximum of 31% of applied in the anaerobic aquatic metabolism study, and at a maximum of 6.9-9.9% of applied in the aerobic soil metabolism study. The available data are insufficient to predict its runoff and fate in surface water characteristics.

The agency does not have any data on tribufos in surface waters, but did perform refined EECs for its use on cotton. The refined EECs are for an edge of the field pond and represent upper bound estimates of concentrations that may occur in such systems. The EECs represent conservative screens for other types of surface waters, including flowing water and lakes and ponds not located at the edge of the field.

c. Environmental Fate and Transport Data

<u>Degradation</u>

161-1 Hydrolysis

Tribufos slowly hydrolyzed in sterile 0.01 M pH 9 borate buffer incubated in the dark for 32 days at 24 C. A hydrolytic half-life of 124 days was calculated in the borate buffered solution. Tribufos did not degrade in sterile pH 5 (0.01 M acetate) and pH 7 (0.01 M phosphate) buffered solutions incubated under identical conditions. At 32 days posttreatment, S,S,S-tributyl phosphorotrithioate was an average of 94.5-94.6% of the recovered radioactivity in the pH 5 and 7 buffered solutions, and was 80.8% in the pH 9 buffered solution. The degradate, desbutylthio DEF was an average of 19.2% of the recovered radioactivity in the pH 9 system at 32 days posttreatment. (MRID 41618814)

161-2 Photodegradation in Water

Tribufos was stable in a pH 5 aqueous buffered solution that was continuously irradiated with a xenon arc lamp at 25 ± 1 C for up to 30 days. Tribufos was 96.3% of the applied radioactivity immediately posttreatment, 95.9-98.9% at 1-21 days, and 93.8% at 30 days. A 254-day first-order half-life was calculated. (MRID 41719401)

161-3 Photodegradation on Soil

Tribufos was stable on a sandy loam soil irradiated for 30 days with natural sunlight in Kentucky during February and March 1988. The parent compound was 100% of the acetonitrile-extracted radioactivity at 30 days posttreatment in both the irradiated and control samples. At 30 days posttreatment, the acetonitrile-extractable radioactivity was 66.0-71.9% of the applied radioactivity in the irradiated samples and 85.4-86.6% in the dark controls. After acetonitrile extraction, the total radiocarbon present in extracted soil ranged from 1.2% to 22.2%; (1.2-10.0% of the applied in the dark controls). Subsequent methanol extraction of Day 30 irradiated replicates removed 10.8% and 11.2% of the unextracted residues, leaving 9.5% and 9.3% remaining bound. In the methanol extracts from the 30-day posttreatment samples, the degradate, butyl mercaptan, was 96.3-100% of the methanol-extracted radioactivity. (MRID 41618816)

<u>Metabolism</u>

162-1 Aerobic Soil Metabolism

Tribufos, at 7 ppm, degraded very slowly in sandy loam soil incubated aerobically in the dark at 25 ± 1 C for up to 360 days. Tribufos was 97.7-100.2% of the applied radioactivity immediately posttreatment, declining to 62.3-66.8% by 360 days. A 745-day half-life was calculated. The degradates identified were 1-butane sulfonic acid, which was a maximum of 6.9-9.9% of the applied at 272 days posttreatment; and, methyl-des butylthio tribufos, which was a maximum of 0.8-1.2% at 181 days. Organic volatiles comprised 2.9-3.9% of the applied radioactivity by the end of the study, and carbon dioxide was 2.9-7.0%. Acid reflux of the extracted soil released an additional 0.4-2.9% of the applied radioactivity which cochromatographed with methyl-des butylthio tribufos. Unextracted radioactivity increased from

0.7-1.5% of the applied immediately posttreatment to 15.4-18.0% at 360 days. (MRID 42007204)

162-2 Anaerobic Soil Metabolism

Tribufos, at 7 ppm, degraded slowly in sandy loam soil incubated anaerobically (nitrogen atmosphere) in the dark at 25 ± 1 C for up to 60 days following a 30-day aerobic incubation period. Tribufos was 106.7-106.8% of the applied radioactivity immediately posttreatment, 90.7-94.5% at 30 days (day 0 of anaerobicity), and 73.0-84.4% at 90 days (60 days of anaerobicity). A 389 day anaerobic half-life was calculated. The degradates identified were 1-butane sulfonic acid, which was detected at maximums of 3.4% of the applied at 61 days posttreatment (31 days of anaerobic incubation) and 3.5% at 90 days (60 days of anaerobic incubation); and, methyl-des butylthio tribufos, which was a maximum of 0.4% at 61 days posttreatment (31 days of anaerobic incubation). Organic volatiles comprised 0.2% of the applied radioactivity at 30 days posttreatment and 0.5% at 90 days posttreatment (60 days of anaerobic incubation); carbon dioxide was 0.4% by the end of the study. Acid reflux of the extracted soil released an additional 0.2-3.0% of the applied radioactivity which cochromatographed with methyl-des butylthio tribufos. Unextracted radioactivity increased from 0.4-0.5% of the applied immediately posttreatment to 4.4-5.3% at 30 days posttreatment, and 7.5-11.7% at 90 days. (MRID 42007205)

162-3 Anaerobic Aquatic Metabolism

Tribufos, at 1.1 µg/ml, degraded with an observed half-life of 4-6 months in flooded silty clay sediment that was incubated anaerobically (nitrogen atmosphere) in the dark at approximately 25 ± 1 C for 12 months. The registrant calculated a half-life of 54.1 days, which is considerably shorter than the observed half-life of 4-6 months. The graphical representation of the data illustrates a pattern of degradation that is clearly not linear, but appears to be biphasic. A half-life of 208 days was calculated by EFGWB using the data from 0-120 days, while a half-life of 44 days was calculated using data from 120-366 days. The registrant provided no explanation for this atypical degradation pattern.

In the floodwater and sediment extracts, [^{14}C]tribufos totaled 88.3% of the applied radioactivity immediately posttreatment, ranged from 81.2 to 89.7% between 2 days and 2 months, and totaled 55.9% at 4 months, 8.1% at 6 months, and 0.9% at 12 months. At all sampling intervals, the majority of the tribufos was associated with the sediment. The concentration of tribufos in the floodwater was 9.0% of the applied immediately posttreatment and decreased to <1% by 3 months. The only degradate identified was 1-butane sulfonic acid (1-BSA), which was a maximum of 29.5-30.6% of the applied at 6 and 9 months posttreatment. 1-BSA was recovered primarily from the floodwater through 2 months posttreatment, and primarily from the sediment at 6 through 12 months. "Remainder" [^{14}C]residues, which consisted of one or more degradates each present at   3.6% of the applied, totaled a maximum 4.5% of the applied at 6 months posttreatment. At 12 months posttreatment, 10.4% of the unextracted [^{14}C]residues were identified as fulvic acid, 1.5% as humic acid, and 88.1% as humin. $^{14}CO_2$ totaled 3.6% of the applied by the end the 12 month study. Other uncharacterized volatile [^{14}C]residues totaled 1.8% by 4 days. No volatiles were isolated in the ethylene glycol or H_2SO_4 trapping solutions beyond 4 days posttreatment. (MRID 43325504)

Mobility

163-1 Leaching and Adsorption/Desorption

Based on batch equilibrium studies, tribufos was not mobile in sand, sandy loam, silt loam, and clay loam soil/calcium chloride solution slurries (1:45, w:v) that were equilibrated for 24 hours at 25 ± 1 C. Freundlich K_{ads} values were 66.8 for the sand soil, 60.6 for the sandy loam soil, 74.3 for the silt loam soil, and 106 for the clay loam soil. Respective K_{oc} values were 12684, 10465, 4870, and 9115. The K_{des} values were 91.3 for the sand soil, 78.1 for the sandy loam soil, 102 for the silt loam soil, and 144.0 for the clay loam soil. (MRID 41618817)

Based on column leaching studies, aged (32 days) tribufos residues were not mobile in duplicate columns (30 cm) of sandy loam soil that were leached with 20 inches of a 0.01 N $CaCl_2$ solution. Following leaching, 90.1 and 99.3% of the applied radioactivity remained in the surface 6 cm of the columns, 0.4% was recovered from each of the deeper column segments, and 0.9-1.0% was in the leachates. In the 0- to 6-cm soil column segments, 71.2-83.7% of the applied radioactivity was tribufos; 6.0-7.3% was "unidentified ETOAc-soluble" [^{14}C]residues, 10.4-20.4% was "unidentified water-soluble" [^{14}C]residues, and 3.6-4.8% of the applied was unextracted. (MRID 42350004)

Field Dissipation

164-1 Soil Field Dissipation

1. This study is unacceptable and cannot be used towards the fulfillment of the terrestrial field dissipation data requirement.

The initial average concentration of tribufos in the 0- to 6-inch soil depth was 0.50 µg/g. The expected concentration, based on the reported application rate of 3.375 lb ai/A, was approximately 1.7 µg/g. Therefore, only 29% of the applied tribufos was accounted for immediately after treatment. It did not appear that the tank mix was sampled to confirm the concentration of tribufos in the treatment solution, or that any attempt was made to confirm the application to the soil surface (such as filter paper discs placed on the soil surface during treatment to intercept the test substance).

Because of the large discrepancy between the reported application rate and the measured concentrations immediately postapplication, the validity of the study is uncertain.

In addition, it is not clear what the route of dissipation was in this study. The 26-day half-life is not supported by the laboratory studies which indicate that tribufos is very stable to both chemical and microbial degradation. Other possible routes of dissipation, including accumulation in plants, volatilization, and leaching, are also not supported by the laboratory data. While it is not unusual to observe faster degradation in the field compared with the laboratory, the differences seen here were not justified (MRID 43325501).

2. This study is unacceptable and cannot be used towards the fulfillment of the terrestrial field dissipation data requirement.

The data were too variable to accurately assess the dissipation of tribufos. Immediately after treatment, the concentration of tribufos in the 0- to 6-inch soil depth varied by >10x.

At the Chualar site immediately after treatment, the concentration of tribufos in 15 samples collected from the 0- to 6-inch soil depth ranged from 0.23 to 3.13 µg/g. The concentration of tribufos in all of the three composite soil samples at each later interval (the 15 soil cores were composited into three samples) did not decrease to <0.23 µg/g until 59 days, the final sampling interval. At the Fresno site, the concentration of tribufos in 15 samples collected from the 0- to 6-inch soil depth ranged from 0.88 to 10.07 µg/g immediately after treatment. Tribufos varied from 0.49 to 1.04 µg/g through 28 days, 0.08 to 0.54 µg/g at 41 through 90 days, and was 0.06-0.47 µg/g at 146 days.

It is not clear what the route of dissipation was in this study. The rapid decline in residues during the first week cannot be explained, given the information provided by the laboratory studies. The laboratory studies show that tribufos is very stable to both chemical and microbial degradation. Other possible routes of dissipation, including accumulation in plants, volatilization, and leaching, are also not supported by the laboratory data. While it is not unusual to observe faster degradation in the field compared with the laboratory, the differences seen here were not justified. Between 0 and 3 days posttreatment, 64% of the tribufos applied to the Chualar site and 78% of that applied to the Fresno site apparently dissipated from the soil. These values were obtained from the average concentrations of residues in the 0- to 6-inch depth at each site at 0 and 3 days posttreatment. At the Chualar site, tribufos averaged 1.46 µg/g at 0 days and 0.53 µg/g at 3 days; at the Fresno site, tribufos averaged 3.21 µg/g at 0 days and 0.70 µg/g at 3 days (MRID 42350005).

E. <u>Accumulation</u>

165-4 Accumulation in Fish

1. Tribufos residues accumulated slightly in bluegill sunfish that were continuously exposed to tribufos at 6.2 µg/L (3.3-7.5 µg/L), for 35 days in a flow-through system. The daily bioconcentration factors ranged from 30-300X for edible tissues, 200-1300X for nonedible

tissues, and 120-730X for whole fish. Maximum tissue [^{14}C]residues were 1800 µg/kg for edible tissues (day 28), 7000 µg/kg for nonedible tissues (day 7), and 4400 µg/kg for whole fish (day 28). After 14 days of depuration, [^{14}C]residues were 430 µg/kg in edible tissues, 830 µg/kg in nonedible tissues, and 690 µg/kg in whole fish. Percent depuration was 71%, 88%, and 83% by the end of the study, respectively (MRID 41618811).

2. [^{14}C]Compounds identified in the nonedible fish tissues were tribufos, S,S-butyl, S-butanol-phosphorotrithioate, and 2-(1-butylthio)-6-(±methyl)-1-oxa-3-thia-2-phosphoracyclohexane-2-oxide. Tribufos was the only [^{14}C]compound detected in the edible tissue and water samples.

The extraction and analysis of the 28-day viscera fraction resulted in the discovery of 47 ^{14}C-components including parent. However, no peak was greater than 4% of total radioactivity in the viscera, except for parent. Parent compound comprised 33% of the total radioactivity. S-butyl, S-butanolphosphorotrithioate was 3.7%, and 2-(1-butylthio)-6-(±methyl)-1-oxa-3-thia-2-phosphoracyclohexane-2-oxide was 3.0%.

Analysis of the organic extracts of the 28-day edible tissues isolated 17 extractable [^{14}C]compounds. Tribufos was 46.2% of the total radioactivity recovered during analysis, and the remainder of [^{14}C]compounds were each <2.4%.

Based on TLC and HPLC analyses of the 28- and 35-day water samples, [^{14}C]tribufos was the only [^{14}C]compound present (MRID 43080401).

3. Exposure and Risk Characterization

Risk characterization integrates the results of the exposure and ecotoxicity data to evaluate the likelihood of adverse ecological effects. The means of integrating the results of exposure and ecotoxicity data is called the quotient method. For this method, risk quotients (RQs) are calculated by dividing exposure estimates by ecotoxicity values, both acute and chronic.

RQ = EXPOSURE/TOXICITY

RQs are then compared to OPP's levels of concern (LOCs). These LOCs are criteria used by OPP to indicate potential risk to nontarget organisms and the need to consider regulatory action. The criteria indicate that a pesticide used as directed has the potential to cause adverse effects on nontarget organisms. LOCs currently address the following risk presumption categories: (1) **acute high** - potential for acute risk is high regulatory action may be warranted in addition to restricted use classification (2) **acute restricted use** - the potential for acute risk is high, but this may be mitigated through restricted use classification (3) **acute endangered species** - the potential for acute risk to endangered species is high regulatory action may be warranted, and (4) **chronic risk** - the potential for chronic risk is high regulatory action may be warranted. Currently, EFED does not perform assessments for chronic risk to plants, acute or chronic risks to nontarget insects, or chronic risk from granular/bait formulations to mammalian or avian species.

The ecotoxicity test values (i.e., measurement endpoints) used in the acute and chronic risk quotients are derived from the results of required studies. Examples of ecotoxicity values derived from the results of short-term laboratory studies that assess acute effects are: (1) LC50 (fish and birds) (2) LD50 (birds and mammals (3) EC50 (aquatic plants and aquatic invertebrates) and (4) EC25 (terrestrial plants). Examples of toxicity test effect levels derived from the results of long-term laboratory studies that assess chronic effects are: (1) LOEC (birds, fish, and aquatic invertebrates) (2) NOEC (birds, fish and aquatic invertebrates) and (3) MATC (fish and aquatic invertebrates). For birds and mammals, the NOEC value is used as the ecotoxicity test value in assessing chronic effects. Other values may be used when justified. Generally, the MATC (defined as the geometric mean of the NOEC and LOEC) is used as the ecotoxicity test value in assessing chronic effects to fish and aquatic invertebrates. However, the NOEC is used if the measurement end point is production of offspring or survival.

Risk presumptions, along with the corresponding RQs and LOCs are tabulated below.

Risk Presumptions for Terrestrial Animals

Risk Presumption	RQ	LOC
Birds		
Acute High Risk	EEC[1]/LC50 or LD50/sqft[2] or LD50/day[3]	0.5
Acute Restricted Use	EEC/LC50 or LD50/sqft or LD50/day (or LD50 < 50 mg/kg)	0.2
Acute Endangered Species	EEC/LC50 or LD50/sqft or LD50/day	0.1
Chronic Risk	EEC/NOEC	1
Wild Mammals		
Acute High Risk	EEC/LC50 or LD50/sqft or LD50/day	0.5
Acute Restricted Use	EEC/LC50 or LD50/sqft or LD50/day (or LD50 < 50 mg/kg)	0.2
Acute Endangered Species	EEC/LC50 or LD50/sqft or LD50/day	0.1
Chronic Risk	EEC/NOEC	1

[1] abbreviation for Estimated Environmental Concentration (ppm) on avian/mammalian food items

[2] $\frac{\text{mg/ft}^2}{\text{LD50 * wt. of bird}}$ [3] $\frac{\text{mg of toxicant consumed/day}}{\text{LD50 * wt. of bird}}$

Risk Presumptions for Aquatic Animals

Risk Presumption	RQ	LOC
Acute High Risk	EEC[1]/LC50 or EC50	0.5
Acute Restricted Use	EEC/LC50 or EC50	0.1
Acute Endangered Species	EEC/LC50 or EC50	0.05
Chronic Risk	EEC/MATC or NOEC	1

[1] EEC = (ppm or ppb) in water

Risk Presumptions for Plants

Risk Presumption	RQ	LOC
Terrestrial and Semi-Aquatic Plants		
Acute High Risk	EEC[1]/EC25	1
Acute Endangered Species	EEC/EC05 or NOEC	1
	Aquatic Plants	
Acute High Risk	EEC[2]/EC50	1
Acute Endangered Species	EEC/EC05 or NOEC	1

[1] EEC = lbs ai/A
[2] EEC = (ppb/ppm) in water

a. Exposure and Risk to Nontarget Terrestrial Animals

For pesticides applied as a nongranular product (e.g., liquid, dust), the estimated environmental concentrations (EECs) on food items following product application are compared to LC50 values to assess risk. The predicted 0-day maximum and mean residues of a pesticide that may be expected to occur on selected avian or mammalian food items immediately following a direct single application at 1 lb ai/A are tabulated below.

Estimated Environmental Concentrations on Avian and Mammalian Food Items (ppm) Following a Single Application at 1 lb ai/A)

Food Items	EEC (ppm) Predicted Maximum Residue[1]	EEC (ppm) Predicted Mean Residue[1]
Short grass	240	85
Tall grass	110	36
Broadleaf/forage plants, and small insects	135	45
Fruits, pods, seeds, and large insects	15	7

[1] Predicted maximum and mean residues are for a 1 lb ai/a application rate and are based on Hoerger and Kenaga (1972) as modified by Fletcher *et al.* (1994).

Predicted residues (EECs) resulting from multiple applications are calculated in various ways. To address multiple applications of tribufos, the FATE program was used with: (1) two applications of 0.75 lb ai/A, applied 10 days apart; (2) an aerobic soil half-life of 745 days; (3) a 10-day exposure scenario for birds; and (4) a 10- and 21-day exposure scenario for mammals (see discussion below).

i. Birds

The acute and chronic risk quotients for broadcast applications of nongranular products are tabulated below.

Avian Acute and Chronic Risk Quotients for Single Application of Nongranular Products (Broadcast) Based on a Bobwhite Quail LC50 of 1519 ppm ai and a Bobwhite Quail NOEC of 148 ppm ai.

Site/App. Method	App. Rate (lbs ai/A)	Food Items	Maximum EEC (ppm)	LC50 (ppm)	NOEC (ppm)	Acute RQ (EEC/ LC50)	Chronic RQ (EEC/ NOEC)
Cotton (Rank, Long Staple (Pima)) aerial	1.875	Short grass	450	1519	148	0.30**	3.04****
		Tall grass	206	1519	148	0.14***	1.39****
		Broadleaf plants/Insects	253	1519	148	0.17***	1.71****
		Seeds	28	1519	148	0.02	0.19
Cotton aerial	1.500	Short grass	360	1519	148	0.24**	2.43****
		Tall grass	165	1519	148	0.11***	1.11****
		Broadleaf plants/Insects	203	1519	148	0.13***	1.37****
		Seeds	23	1519	148	0.02	0.16
Cotton aerial	1.125	Short grass	270	1519	148	0.18***	1.82****
		Tall grass	124	1519	148	0.08	0.84
		Broadleaf plants/Insects	152	1519	148	0.10***	1.03****
		Seeds	17	1519	148	0.01	0.11
Cotton aerial	1.000	Short grass	240	1519	148	0.16***	1.62****
		Tall grass	110	1519	148	0.07	0.74
		Broadleaf plants/Insects	135	1519	148	0.09	0.91
		Seeds	15	1519	148	0.01	0.10
Cotton aerial	0.750	Short grass	180	1519	148	0.12***	1.22****
		Tall grass	83	1519	148	0.05	0.56
		Broadleaf plants/Insects	101	1519	148	0.07	0.68
		Seeds	11	1519	148	0.01	0.07

* exceeds acute high, acute restricted and acute endangered species LOCs.
** exceeds acute restricted and acute endangered species LOCs.
*** exceeds acute endangered species LOC.
**** exceeds chronic LOC.

The results indicate that for a single broadcast application of nongranular products, the avian acute high risk LOC (0.5) is not exceeded for any use rate. However, the avian acute restricted use LOC (0.2) and acute endangered species LOC (0.1) are exceeded at registered application rates of 1.5 and 1.875 lb ai/acre for short grass. Further, the acute endangered species LOC (0.1) and the avian chronic LOC (1.0) are exceeded for different food items at all registered use rates. Avian acute risks may be mitigated by restricted use; chronic risks to nontarget avian species are likely. Endangered avian species may be affected acutely and chronically.

The following table presents avian acute and chronic risk quotients for multiple, broadcast applications of nongranular products.

Avian Acute and Chronic Risk Quotients for Multiple Applications of Nongranular Products (Broadcast) Based on a Bobwhite Quail LC50 of 1519 ppm ai and a Bobwhite Quail NOEC of 148 ppm ai.

Site/App. Method	App.Rate (lbs ai/A) No. of Apps.	Food Items	Maximum EEC[1] (ppm)	LC50 (ppm)	NOEC (ppm)	Acute RQ (EEC/ LC50)	Chronic RQ (EEC/ NOEC)
Cotton (Rank) aerial	0.75 (2)	Short grass	358	1519	148	0.24**	2.42****
		Tall grass	164	1519	148	0.11***	1.11****
		Broadleaf plants/Insects	202	1519	148	0.13***	1.36****
		Seeds	22	1519	148	0.01	0.15

[1] Assumptions using FATE program: degradation occurs, based on aerobic soil half-life of 745 days; 10-day application interval occurs between two applications; and maximum residues (EEC) from Fletcher *et al* (1994) are used.

* exceeds acute high, acute restricted and acute endangered species LOCs.
** exceeds acute restricted and acute endangered species LOCs.
*** exceeds acute endangered species LOC.
**** exceeds chronic LOC.

The results indicate that for multiple broadcast applications of nongranular products (0.75 lb ai/A applied twice), and based on maximum residues, the avian acute high risk LOC (0.5) is not exceeded for any food item. However, the avian acute restricted use LOC (0.2) is exceeded for short grass. The acute endangered species LOC (0.1) and chronic LOC (1.0) are exceeded for all food items except seeds. Avian acute risks may be mitigated by restricted use; chronic risks to nontarget avian species are likely. Endangered avian species may be affected acutely and chronically.

Chronic risk quotients can be calculated based on the average residues on food items. Average residues result from the pesticide being applied repeatedly, but degrading over the course of time from the first application to the last application. Avian chronic risk quotients based on average residues for multiple, broadcast applications of non-granular products are tabulated below.

Avian Chronic Risk Quotients for Multiple Applications of Nongranular Products (Broadcast) Based on a Bobwhite Quail NOEC of 148 ppm ai and Average Residues.

Site/App. Method	App.Rate (lbs ai/A) No. of Apps.	Food Items	Average EEC[1] (ppm)	NOEC (ppm)	Chronic RQ (EEC/ NOEC)
Cotton (Rank) aerial	0.75 (2)	Short grass	196	148	1.32*
		Tall grass	90	148	0.61
		Broadleaf plants/Insects	110	148	0.74
		Seeds	12	148	0.08

[1] Assumptions using FATE program: degradation occurs, based on aerobic soil half-life of 745 days; 10-day application interval occurs between two applications; and average residues (EEC) from Fletcher *et al* (1994) are used.

* exceeds chronic LOC.

The results indicate that for multiple broadcast applications of nongranular products (0.75 lb ai/acre applied twice) and based on average residues, the avian chronic LOC (1.0) is exceeded for short grass. For the food items, tall grass and broadleaf plants/insects, RQs approach, but do not exceed, the LOC (1.0). Chronic risks to nontarget avian species are likely, and endangered species may be affected chronically.

ii. Mammals

Birds and mammals have similar responses to xenobiotics, and their differences are more quantitative rather than qualitative. Birds have lower hepatic microsomal mono-oxygenase and A-esterase activity than do mammals. Therefore, birds generally are more susceptible than mammals to both organophosphate and carbamates. However, mammals appear to be as, or more, susceptible than birds to tribufos.

Estimating the potential for adverse effects to wild mammals is based upon EEB's draft 1995 SOP of mammalian risk assessments and methods used by Hoerger and Kenaga (1972) as modified by Fletcher *et al.* (1994). The concentration of tribufos in the diet that is expected to be acutely lethal to 50% of the test population (LC50) is determined by dividing the LD50 value (usually rat LD50) by the % (decimal of) body weight consumed. A risk quotient is then determined by dividing the EEC by the derived LC50 value. Risk quotients are calculated for three separate weight classes of mammals (15, 35, and 1000 g), each presumed to consume four different kinds of food (grass, forage, insects, and seeds).

Acute risk quotients are tabulated below for herbivorous and insectivorous mammals from single, broadcast applications of nongranular products.

Acute Risk Quotients - Single Application:

Mammalian (Herbivore/Insectivore) Acute Risk Quotients for Single Application of Nongranular Products (Broadcast) Based on a Rat LD50 of 192 mg/kg.

Site/ Application Method/ Rate in lbs ai/A	Body Weight (g)	% Body Weight Consumed	Rat LD50 (mg/kg)	EEC[1] (ppm) Short Grass	EEC (ppm) Forage & Small Insects	EEC (ppm) Large Insects	Acute RQ[2] Short Grass	Acute RQ Forage & Small Insects	Acute RQ Large Insects
Cotton aerial									
1.875	15	95	192	450	253	28	2.23	1.25	0.14
1.875	35	66	192	450	253	28	1.55	0.87	0.10
1.875	1000	15	192	450	253	28	0.35	0.20	0.02
1.500	15	95	192	360	203	23	1.78	1.00	0.11
1.500	35	66	192	360	203	23	1.24	0.70	0.08
1.500	1000	15	192	360	203	23	0.28	0.16	0.02
1.125	15	95	192	270	152	17	1.34	0.75	0.08
1.125	35	66	192	270	152	17	0.93	0.52	0.06
1.125	1000	15	192	270	152	17	0.21	0.12	0.01
1.000	15	95	192	240	135	15	1.19	0.67	0.07
1.000	35	66	192	240	135	15	0.83	0.46	0.05
1.000	1000	15	192	240	135	15	0.19	0.11	0.01
0.750	15	95	192	180	101	11	0.89	0.50	0.05
0.750	35	66	192	180	101	11	0.62	0.35	0.04
0.750	1000	15	192	180	101	11	0.14	0.08	0.01

[1] Assumption: no degradation

[2] $RQ = \frac{\text{EEC (ppm)}}{\text{LD50 (mg/kg)/ \% Body Weight Consumed}}$

Acute risk quotients are tabulated below for herbivorous and insectivorous mammals from single, broadcast applications of nongranular products.

Mammalian (Granivore) Acute Risk Quotients for Single Application of Nongranular Products (Broadcast) Based on a Rat LD50 of 192 mg/kg.

Site/ Application Method/Rate in lbs ai/A	Body Weight (g)	% Body Weight Consumed	Rat LD50 (mg/kg)	EEC[1] (ppm) Seeds	Acute RQ[2] Seeds
Cotton aerial					
1.875	15	21	192	28	0.03
1.875	35	15	192	28	0.02
1.875	1000	3	192	28	0.00
1.500	15	21	192	23	0.03
1.500	35	15	192	23	0.02
1.500	1000	3	192	23	0.00
1.125	15	21	192	17	0.02
1.125	35	15	192	17	0.01
1.125	1000	3	192	17	0.00
1.000	15	21	192	15	0.02
1.000	35	15	192	15	0.01
1.000	1000	3	192	15	0.00
0.750	15	21	192	11	0.01
0.750	35	15	192	11	0.01
0.750	1000	3	192	11	0.00

[1] Assumption: no degradation

[2] $RQ = \frac{\text{EEC (ppm)}}{\text{LD50 (mg/kg)/ \% Body Weight Consumed}}$

The results indicate that for a single broadcast application of nongranular products, the mammalian acute high risk (0.5), acute restricted use (0.2), and acute endangered species (0.1) LOCs are exceeded for all use rates for 15g and 35g herbivores and insectivores that feed on short grass and forage/small insects. The mammalian acute endangered species LOC (0.1) is exceeded for 15g and 35g herbivores and insectivores that feed on large insects following applications at 1.875 lbs ai/A and 1.500 lbs ai/A. For all use rates, acute risks to nontarget herbivores and insectivores are likely; endangered herbivores and insectivores may be affected acutely.

For granivorous mammals, the results indicate that for broadcast applications of nongranular products, no mammalian acute LOCs are exceeded at any registered application rate.

The following table shows acute risk quotients for herbivorous and insectivorous mammals based on multiple, broadcast applications of nongranular products.

Acute Risk Quotients - Multiple Applications:

Mammalian (Herbivore/Insectivore) Acute Risk Quotients For Multiple Applications of Nongranular Products (Broadcast) Based on a Rat LD50 of 192 mg/kg.

Site/ App. Method/ Rate in lbs ai/A (No. of Apps.)	Body Weight (g)	% Body Weight Consumed	Rat LD50 (mg/kg)	EEC[1] (ppm) Short Grass	EEC (ppm) Forage & Small Insects	EEC (ppm) Large Insects	Acute RQ[2] Short Grass	Acute RQ Forage & Small Insects	Acute RQ Large Insects
Cotton (Rank) aerial									
0.75 (2)	15	95	192	358	202	22	1.77	1.00	0.11
0.75 (2)	35	66	192	358	202	22	1.23	0.69	0.08
0.75 (2)	1000	15	192	358	202	22	0.28	0.16	0.02

1 Assumptions using FATE program: degradation occurs, based on aerobic soil half-life of 745 days; 10-day application interval occurs between two applications; and maximum residues (EEC) from Fletcher *et al* (1994) are used.

2 $RQ = \frac{\text{EEC (ppm)}}{\text{LD50 (mg/kg)/ \% Body Weight Consumed}}$

The following table shows acute risk quotients for granivorous mammals based on multiple, broadcast applications of nongranular products.

Mammalian (Granivore) Acute Risk Quotients for Multiple Applications of Nongranular Products (Broadcast) Based on a Rat LD50 of 192 mg/kg.

Site/ App. Method/Rate in lbs ai/A (No. of Apps.)	Body Weight (g)	% Body Weight Consumed	Rat LD50 (mg/kg)	EEC[1] (ppm) Seeds	Acute RQ[2] Seeds
Cotton (Rank) aerial					
0.75 (2)	15	21	192	22	0.02
0.75 (2)	35	15	192	22	0.02
0.75 (2)	1000	3	192	22	0.00

1 Assumptions using FATE program: degradation occurs, based on aerobic soil half-life of 745 days; 10-day application interval occurs between two applications; and maximum residues (EEC) from Fletcher *et al* (1994) are used.

2 $RQ = \frac{\text{EEC (ppm)}}{\text{LD50 (mg/kg)/ \% Body Weight Consumed}}$

The results indicate that for multiple applications of nongranular products (0.75 lb ai/A, applied twice), the mammalian acute high risk (0.5), acute restricted use (0.2), and acute endangered species (0.1) LOCs are exceeded for herbivores and insectivores that feed on short grass and forage/small insects. The mammalian acute endangered species LOC (0.1) is exceeded for herbivores and insectivores feeding on large insects. Acute risks to nontarget herbivores and insectivores are likely; endangered herbivores and insectivores may be affected acutely.

For granivorous mammals the results indicate that for multiple broadcast applications of nongranular products (0.75 lb ai/A, applied twice), no mammalian acute LOCs are exceeded.

The chronic risk quotients for broadcast applications of nongranular products are tabulated below.

Chronic Risk Quotients - Single Application (High Exposure - 0 Days):

Mammalian Chronic Risk Quotients for Single Application of Nongranular Products (Broadcast) Based on a Rat NOEC of 32 ppm in a Rat 2-Generation Reproduction Study

Site/App. Method	App. Rate (lbs ai/A)	Food Items	Maximum EEC[1] (ppm)	NOEC (ppm)	Chronic RQ (EEC/ NOEC)
Cotton (Rank, Long Staple (Pima)) aerial	1.875	Short grass	450	32	14.06*
		Tall grass	206	32	6.44*
		Broadleaf plants/Insects	253	32	7.91*
		Seeds	28	32	0.88
Cotton aerial	1.500	Short grass	360	32	11.25*
		Tall grass	165	32	5.16*
		Broadleaf plants/Insects	203	32	6.34*
		Seeds	23	32	0.72
Cotton aerial	1.125	Short grass	270	32	8.44
		Tall grass	124	32	3.88*
		Broadleaf plants/Insects	152	32	4.75*
		Seeds	17	32	0.53
Cotton aerial	1.000	Short grass	240	32	7.50*
		Tall grass	110	32	3.44*
		Broadleaf plants/Insects	135	32	4.22*
		Seeds	15	32	0.47
Cotton aerial	0.750	Short grass	180	32	5.63*
		Tall grass	83	32	2.59*
		Broadleaf plants/Insects	101	32	3.16*
		Seeds	11	32	0.34

[1] Assumption: No degradation

* exceeds chronic LOC.

High Exposure Scenario (maximum residues with no degradation): The above results indicate that for a single broadcast application of nongranular products, the mammalian chronic LOC (1.0) is exceeded for all use rates. Chronic risks to nontarget mammals are likely; endangered mammals may be affected chronically.

The following table shows mammalian chronic risk quotients for a single, broadcast application of nongranular products based on an average exposure over 21 days.

Chronic Risk Quotients - Single Application (Lower (Average) Exposure - 21-Days):

Mammalian Chronic Risk Quotients for Single Application of Nongranular Products (Broadcast) Based on a Rat NOEC of 32 ppm in a Rat 2-Generation Reproduction Study

Site/App. Method	App. Rate (lbs ai/A)	Food Items	Average EEC[1] (ppm)	NOEC (ppm)	Chronic RQ (EEC/ NOEC)
Cotton (Rank, Long Staple (Pima)) aerial	1.875	Short grass	446	32	13.94*
		Tall grass	204	32	6.38*
		Broadleaf plants/Insects	251	32	7.84*
		Seeds	28	32	0.88
Cotton aerial	1.500	Short grass	357	32	11.16*
		Tall grass	163	32	5.09*
		Broadleaf plants/Insects	201	32	6.28*
		Seeds	22	32	0.69
Cotton aerial	1.125	Short grass	267	32	8.34
		Tall grass	123	32	3.84*
		Broadleaf plants/Insects	150	32	4.69*
		Seeds	17	32	0.53
Cotton aerial	1.000	Short grass	238	32	7.44*
		Tall grass	109	32	3.41*
		Broadleaf plants/Insects	134	32	4.19*
		Seeds	15	32	0.47
Cotton aerial	0.750	Short grass	178	32	5.56*

Mammalian Chronic Risk Quotients for Single Application of Nongranular Products (Broadcast) Based on a Rat NOEC of 32 ppm in a Rat 2-Generation Reproduction Study

Site/App. Method	App. Rate (lbs ai/A)	Food Items	Average EEC[1] (ppm)	NOEC (ppm)	Chronic RQ (EEC/ NOEC)
		Tall grass	82	32	2.56*
		Broadleaf plants/Insects	100	32	3.13*
		Seeds	11	32	0.34

[1] Assumptions: For single application rates of 1.875, 1.500, 1.125, 1.000, and 0.750 lb ai/acre FATE determined average rates of 1.857, 1.485, 1.114, 0.990, and 0.743 lb ai/acre, respectively, for a 21-day exposure period, using a 745-day aerobic soil half-life. This time period was chosen since it covers the typical gestation period for certain small mammal species (e.g., *Peromyscus leucopus*, white-footed mouse, gestation period is 21 to 25 days in length).

* exceeds chronic LOC.

Lower (Average) Exposure Scenario (average residues with 21-day exposure): The Agency also examined a lower (average) exposure scenario because, typically, organisms will not be exposed to maximum tribufos residues throughout their breeding cycle. More likely, such animals would be exposed to initial maximum residues followed by declining residues. In order to address such a scenario the Agency utilized an average of such residues for the time period 21 days, a period that should cover the shortest gestation period for a representative small mammal such as the white-footed mouse, *Peromyscus leucopus*. This scenario indicates that for a single broadcast application of nongranular products, the mammalian chronic LOC (1.0) is exceeded for all use rates. Chronic risks to nontarget mammals are likely; endangered mammals may be affected chronically.

The following table shows mammalian chronic risk quotients for multiple, broadcast application of nongranular products based on an average exposure over 10 days.

Chronic Risk Quotients - Multiple Applications (High and Lower (Average) Exposure - 10-Days):

Mammalian Chronic Risk Quotients for Multiple Applications of Nongranular Products (Broadcast) Based on a Rat NOEC of 32 ppm in a Rat 2-Generation Reproduction Study

Site/Application Method	Application Rate in lbs ai/A (No. of Apps.)	Food Items	Max. EEC[1] (ppm)	Ave. EEC[1] (ppm)	NOEC (ppm)	Chronic RQ Max. EEC/NOEC)	Chronic RQ (Ave. EEC/NOEC)
Cotton (Rank) aerial	0.75 (2)	Short grass	358	196	32	11.19*	6.13*
		Tall grass	164	90	32	5.13*	2.81*
		Broadleaf plants/Insects	202	110	32	6.31*	3.44*
		Seeds	22	12	32	0.69	0.38

[1] Assumptions using FATE program: degradation occurs, based on aerobic soil half-life of 745 days; 10-day application interval occurs between two applications; and maximum and average (for 10-day time period) residues (EEC) from Fletcher *et al* (1994) are used.

* exceeds chronic LOC.

High Exposure Scenario (maximum and average residues; 10-day exposure): The above results indicate that for multiple applications of nongranular products (0.75 lb ai/A applied twice), the mammalian chronic LOC (1.0) is exceeded for both maximum and average residues. Chronic risks to nontarget mammals are likely; endangered mammals may be affected chronically.

The following table shows mammalian chronic risk quotients for multiple, broadcast application of nongranular products based on an average exposure over 21 days.

Chronic Risk Quotients - Multiple Applications (Lower (Average) Exposure - 21-Days):

Mammalian Chronic Risk Quotients for Nongranular Products (Broadcast) Based on a Rat NOEC of 32 ppm in a Rat 2-Generation Reproduction Study

Site/Application Method	Application Rate in lbs ai/A (No. Apps.)	Food Items	Average EEC[1] (ppm)	NOEC (ppm)	Chronic RQ (EEC/NOEC)
Cotton (Rank) (aerial)	0.75 (2)	Short grass	276	32	8.63*
		Tall grass	126	32	3.94*
		Broadleaf plants/Insects	155	32	4.84*
		Seeds	17	32	0.53

[1] Assumptions: For two applications of 0.75 lb ai/acre, applied 10 days apart, FATE determined an average rate of 1.15 lb ai/acre for a 21-day exposure period, using a 745-day aerobic soil half-life. This time period was chosen since it covers the typical gestation period for certain small mammal species (e.g., *Peromyscus leucopus*, white-footed mouse, gestation period is 21 to 25 days in length).

* exceeds chronic LOC.

Lower (Average) Exposure Scenario (average residues; 21-day exposure): The Agency also examined a lower (average) exposure scenario because, typically, organisms will not be exposed to maximum tribufos residues throughout their breeding cycle. More likely, such animals would be exposed to initial maximum residues followed by declining residues. In order to address such a scenario the Agency utilized an average of such residues for the time period 21 days, a period that should cover the shortest gestation period for a representative small mammal such as the white-footed mouse, *Peromyscus leucopus*. This scenario indicates that for multiple applications of nongranular products (0.75 lb ai/A applied twice), the mammalian chronic LOC (1.0) is exceeded. Chronic risks to nontarget mammals are likely; endangered mammals may be affected chronically.

iii. Insects

Currently, EFED does not assess risk to nontarget insects. Results of acceptable studies are used for recommending appropriate label precautions.

b. Exposure and Risk to Nontarget Freshwater Aquatic Animals

EFED calculates EECs using the GENeric Expected Environmental Concentration Program (GENEEC). The EECs are used for assessing acute and chronic risks to aquatic organisms. Acute risk assessments are performed using either 0-day EEC values for single application or peak EEC values for multiple applications. Chronic risk assessments are performed using the 21-day EECs for invertebrates and 56-day EECs for fish.

The GENEEC program uses basic environmental fate data and pesticide label application information to estimate the expected EECs following treatment of 10 hectares. The model calculates the concentration (i.e. EEC) of a pesticide in a one hectare, two meter deep pond, taking into account the following: (1) adsorption to soil or sediment (2) soil incorporation (3) degradation in soil before washoff to a water body and (4) degradation within the water body. The model also accounts for direct deposition of spray drift into the water body (assumed to be 1% and 5% of the application rate for ground and aerial applications, respectively). **(When multiple applications are permitted:** The interval between applications is included in the calculations. The environmental fate parameters used in the model for this pesticide are: soil K_{OC} - 9283 L/kg, solubility - 2.3 mg/L , aerobic soil metabolism half-life - 745 days, hydrolysis - stable, water photolysis - 254 days, aquatic metabolism - not available. EECs are tabulated below.

EFED uses environmental fate and transport computer models to calculate refined EECs. The Pesticide Root Zone Model (PRZM2) simulates pesticides in field runoff. The Exposure Analysis Modeling System (EXAM II) simulates pesticide fate and transport in an aquatic environment (one hectare body of water, two meters deep). EECs are tabulated below.

Estimated Environmental Concentrations (EECs) For Aquatic Exposure

Site	Application Method	Application Rate (lbs ai/A)	# of Apps./ Interval Between Apps.	Initial (PEAK) EEC (ppm)	21-day average EEC (ppm)	56-day average EEC[1] (ppm)
GENEEC						
Cotton	aerial application of liquid formulation	1.875	1	0.008	0.003	0.002
Cotton	ground unincorporated	1.875	1	0.005	0.002	0.001
Cotton	aerial application of liquid formulation	0.750[2]	2 (10 days)	0.006	0.002	0.002
Cotton	ground unincorporated	0.750[2]	2 (10 days)	0.004	0.002	0.001
PRIZM2/EXAM II						
Cotton (Mississippi)[3]	aerial application of liquid formulation	1.875	1	0.014	0.007	0.005
Cotton (Texas)	aerial application of liquid formulation	1.875	1	0.008	0.003	0.002
Cotton (California)	aerial application of liquid formulation	1.875	1	0.0003	0.0001	0.0001

[1] PRIZM2/EXAM II calculates a 60-day EEC, which is what appears in this column under PRZM2/EXAM II.
[2] A PRIZM2/EXAM II run was not performed for this scenario because a single application of 1.875 lbs ai/A provides a high exposure scenario.

[3] California represents a dry climate; Mississippi, a wet climate; and Texas, a moderate climate.

ii. Freshwater Fish

Acute and chronic risk quotients are tabulated below.

Risk Quotients for Freshwater Fish Based On a Bluegill Sunfish LC50 of 0.245 ppm ai.

Site/ Application Method/ Rate in lbs ai/A (No. of Apps.)	LC50 (ppm)	NOEC/ MATC (ppm)	EEC Initial/Peak (ppm)	EEC 56-Day Ave. (ppm)	Acute RQ (EEC/LC50)	Chronic RQ (EEC/NOEC or MATC)
Cotton (Mississippi) 1.875 (1)	0.245	N/A	0.014	0.005	0.06	N/A
Cotton (Texas) 1.875 (1)	0.245	N/A	0.008	0.002	0.03	N/A
Cotton (California) 1.875 (1)	0.245	N/A	0.0003	0.0001	0.00	N/A

Cotton - Mississippi Scenario: The results indicate that the acute endangered species LOC (0.05) is exceeded for freshwater fish at a registered maximum application rate equal to or above 1.875 lb ai/A. Endangered fish may be affected acutely; however, chronic effects data for fish are lacking.

Cotton - Texas and California Scenarios: The results indicate that aquatic acute high risk (0.5), acute restricted use (0.1), and acute endangered species (0.05) LOCs are not exceeded for freshwater fish at a registered maximum application rate equal to or above 1.875 lb ai/A. Chronic effects data for fish are lacking.

ii. Freshwater Invertebrates

The acute and chronic risk quotients are tabulated below.

Risk Quotients for Freshwater Invertebrates Based On a *Gammarus pseudolimnaeus* LC50 of 0.027 ppm ai and a *Daphnia magna* MATC of 0.002 ppm ai.

Site/ Application Method/ Rate in lbs ai/A (No. of Apps.)	LC50 (ppm)	MATC (ppm)	EEC Initial/Peak (ppm)	EEC 21-Day Average	Acute RQ (EEC/LC50)	Chronic RQ (EEC/NOEC or MATC)
Cotton (Mississippi) 1.875 (1)	0.027	0.002	0.014	0.007	0.52	3.50
Cotton (Texas) 1.875 (1)	0.027	0.002	0.008	0.003	0.30	1.50
Cotton (California) 1.875 (1)	0.027	0.002	0.0003	0.0001	0.01	0.05

Cotton - Mississippi Scenario: The results indicate that aquatic acute high risk (0.5), acute restricted use (0.1), acute endangered species (0.05), and chronic (1.0) LOCs are exceeded for freshwater invertebrates at a registered maximum application rate equal to or above 1.875 lb ai/A. Acute and chronic risks to nonendangered freshwater invertebrates are likely; endangered freshwater invertebrates may be affected acutely and chronically.

Cotton - Texas Scenario: The results indicate that the aquatic acute restricted use (0.1), acute endangered species (0.05), and chronic (1.0) LOCs are exceeded for freshwater invertebrates at a registered maximum application rate equal to or above 1.875 lb ai/A. Acute risks to nonendangered freshwater invertebrates may be mitigated by restricted use; however, endangered freshwater invertebrates may be affected acutely. Chronic risks to nontarget freshwater invertebrates are likely; endangered freshwater invertebrates may be affected chronically.

Cotton - California Scenario: The results indicate that aquatic acute high risk (0.5), acute restricted use (0.1), acute endangered species (0.05), and chronic (1.0) LOCs are not exceeded for freshwater invertebrates at a registered maximum application rate equal to or above 1.875 lb ai/A.

c. Estuarine and Marine Animals

The acute and chronic risk quotients for estuarine/marine fish are tabulated below.

Risk Quotients for Estuarine/Marine Fish Based On a Spot LC50 of 0.130 ppm ai.

Site/ Application Method/ Rate in lbs ai/A (No. of Apps.)	LC50 (ppm)	NOEC/ MATC (ppm)	EEC Initial/Peak (ppm)	EEC 56-Day Ave. (ppm)	Acute RQ (EEC/LC50)	Chronic RQ (EEC/NOEC or MATC)
Cotton (Mississippi) 1.875 (1)	0.130	N/A	0.014	0.005	0.11	N/A
Cotton (Texas) 1.875 (1)	0.130	N/A	0.008	0.002	0.06	N/A

Cotton - California Scenario: Risk quotients were not calculated because use of tribufos on cotton in California is not expected to impact estuarine/marine environments.

Cotton - Texas Scenario: The results indicate that the aquatic acute endangered species (0.05) LOC is exceeded for estuarine/marine fish at a registered maximum application rate equal to or above 1.875 lb ai/A. Endangered estuarine/marine fish may be affected acutely. However, chronic effects data for fish are lacking.

Cotton - Mississippi Scenario: The results indicate that aquatic acute restricted use (0.1) and acute endangered species (0.05) LOCs are exceeded for estuarine/marine fish at a registered maximum application rate equal to or above 1.875 lb ai/A. Acute risks to nonendangered estuarine/marine fish may be mitigated by restricted use; endangered estuarine/marine fish may be affected acutely. However, chronic effects data for fish are lacking.

The following table shows the acute and chronic risk quotients for estuarine/marine invertebrates.

Risk Quotients for Estuarine/Marine Aquatic Invertebrates Based On a Mysid LC50 of 0.005 ppm ai and a Mysid LOEC of 0.0003 ppm ai.[1]

Site/ Application Method/ Rate in lbs ai/A (No. of Apps.)	LC50 (ppm)	LOEC (ppm)	EEC Initial/Peak (ppm)	EEC 21-Day Average	Acute RQ (EEC/LC50)	Chronic RQ (EEC/NOEC or MATC)
Cotton (Mississippi) 1.875 (1)	0.005	0.0003	0.014	0.007	2.80	23.33
Cotton (Texas) 1.875 (1)	0.005	0.0003	0.008	0.003	1.60	10.00

[1] A MATC was not determined. NOEC: < 0.0003 ppm ai; LOEC: 0.0003 ppm ai.

Cotton - California Scenario: Risk quotients were not calculated because use of tribufos on cotton in California is not expected to impact estuarine/marine environments.

Cotton - Texas and Mississippi Scenarios: The results indicate that the aquatic acute high risk (0.5), acute restricted use (0.1), acute endangered species (0.05), and chronic (1.0) LOCs are exceeded for estuarine/marine invertebrates at a registered maximum application rate equal to or above 1.875 lb ai/A. Acute and chronic risks to nonendangered estuarine/marine are likely: endangered estuarine/marine invertebrates may be affected acutely and chronically.

d. Exposure and Risk to Nontarget Plants

i. Terrestrial and Semi-aquatic

Terrestrial and semi-aquatic plants may be exposed to pesticides from runoff, spray drift or volatilization. Semi-aquatic plants are those that inhabit low-lying wet areas that may be dry at certain times of the year. EFED's runoff scenario is: (1) based on a pesticide's water solubility and the amount of pesticide present on the soil surface and its top one inch (2) characterized as "sheet runoff" (one treated acre to an adjacent acre) for terrestrial plants (3) characterized as "channelized runoff" (10 treated acres to a distant low-lying acre) for semi-aquatic plants and (4) based on % runoff values of 0.01, 0.02, and 0.05 for water solubility of <10 ppm, 10-100 ppm, and >100 ppm, respectively.

Spray drift exposure from ground application is assumed to be 1% of the application rate. Spray drift from aerial, airblast, forced-air, and chemigation applications is assumed to be 5% of the application rate.

EECs are calculated for the following application methods: (1) unincorporated ground applications, (2) incorporated ground application, and (3) aerial, airblast, forced-air, and chemigation applications. Formulae for calculating EECs for terrestrial plants inhabiting areas adjacent to treatment sites and EECs for semi-aquatic plants inhabiting wet, low-lying areas are in an addendum.

Nontarget terrestrial plant data are lacking; therefore, the Agency was unable to develop risk quotients.

ii. Aquatic Plants

Exposure to nontarget aquatic plants may occur through runoff or spray drift from adjacent treated sites or directly from such uses as aquatic weed or mosquito larvae control. An aquatic plant risk assessment for acute high risk is usually made for aquatic vascular plants from the surrogate duckweed *Lemna gibba*. Non-vascular acute high risk assessments for aquatic plants are performed using either algae or a diatom, whichever is the most sensitive species. An aquatic plant risk assessment for acute- endangered species is usually made for aquatic vascular plants from the surrogate duckweed *Lemna gibba*. To date there are no known non-vascular plant species on the endangered species list. Runoff and drift exposure is computed from either GENEEC or PRIZM3/EXAMS 2.95. The risk quotient is determined by dividing the pesticide's initial or peak concentration in water by the plant EC50 value.

Acute risk quotients for nonvascular plants (vascular plant data are lacking) are tabulated below.

Acute Risk Quotients for Aquatic Plants based upon a nonvascular plant (freshwater green alga, *Kirchneria subcapitata*) EC50 of 0.148 ppm ai.[1]

Site/ Application Method/ Rate of Application in lbs ai/A (No. of Apps.)	Test Species	EC50 (ppm)	EEC (ppm)	RQ (EEC/ EC50)
Cotton (Mississippi) 1.875 (1)	algae	0.148	0.014	0.09
Cotton (Texas) 1.875 (1)	algae	0.148	0.008	0.05
Cotton (California) 1.875 (1)	algae	0.148	0.0003	0.00

[1] Data for aquatic vascular plants are lacking.

Endangered species risk quotients for vascular aquatic plants are tabulated below. (Non-vascular endangered species are not known to exist at this time).

Endangered Species Risk Quotients for Aquatic Plants based upon a nonvascular plant (freshwater green alga, *Kirchneria subcapitata*) NOEC of 0.118 ppm ai.[1]

Site/ Application Method/ Rate of Application in lbs ai/A (No. of Apps.)	Test Species	NOEC (ppm)	EEC (ppm)	RQ (EEC/ EC50)
Cotton (Mississippi) 1.875 (1)	algae	0.118	0.014	0.12
Cotton (Texas) 1.875 (1)	algae	0.118	0.008	0.07
Cotton (California) 1.875 (1)	algae	0.118	0.0003	0.00

[1] Data for aquatic vascular plants are lacking.

Cotton - California, Texas, and Mississippi Scenarios: The results indicate that non-endangered (1.0) and endangered plant (1.0) acute LOCs are not exceeded for nonvascular aquatic plants at a registered maximum application rate equal to or above 1.875 lb ai/A. Effects data for aquatic vascular plants are lacking.

4. Endangered Species

Endangered species LOCs are exceeded for birds (single and multiple applications), mammals (single and multiple applications), freshwater fish (Mississippi scenario), freshwater invertebrates (Texas and Mississippi scenarios), and estuarine/marine fish and invertebrates (Texas and Mississippi scenarios).

The Endangered Species Protection Program is expected to become final in the future. Limitations in the use of tribufos may be required to protect endangered and threatened species, but these limitations have not been defined and may be formulation specific. EPA anticipates that a consultation with the Fish and Wildlife Service may be conducted in accordance with the species-based priority approach described in the Program. After completion of consultation, registrants will be informed if any required label modifications are necessary. Such modifications would most likely consist of the generic label statement referring pesticide users to use limitations contained in county Bulletins.

5. Risk Characterization

Tribufos is unique for several reasons: It is an organophosphate compound used as a defoliant (alone and tank mixed with other chemicals), it is unusually persistent, and it is applied in the fall.

According to information provided by BEAD, the use of tribufos has been rising from 1991 - 1994. In 1991, it was probably applied to more than 1 million acres, or <10% of planted acreage. In 1994, tribufos was applied to 4 million - 5 million acres, or about 30% - 35% of planted acreage. Usually, one application of tribufos is made at a rate of <1 lb ai/A; occasionally, two applications are made.

A major concern with tribufos is chronic risk because it is immobile and unusually persistent. However, EFED's assessment and characterization of the chronic risk from this chemical is incomplete. Crucial data are missing on field dissipation, freshwater and estuarine/marine fish life cycles, and non-target plants. Tribufos is applied in the fall -- outside the breeding season for birds and aquatic species -- so the data are particularly important to understanding possible exposures to avian and aquatic species in the spring.

Though data are not available to support this, EFED believes that in some areas of the country, tribufos is applied mostly by aircraft. This is because the wheels of the ground equipment used to apply tribufos can damage the mature cotton plants and the wet soil may not be firm enough to support the equipment. The application method is important because some labels for tribufos already carry warnings to avoid contaminating surface water via aerial applications.

The following is a summary of risk for non-target organisms.

A. Avian Species

Acute Risks

Acute risks to nonendangered avian species are not likely; any potential acute risks may be mitigated by restricted use classification. For single, broadcast applications of nongranular products, risk quotients (RQs) ranged from 0.10 to 0.30. For multiple, broadcast applications of nongranular products, RQs ranged from 0.11 to 0.24.

Endangered avian species may be affected acutely, considering that such organisms may be more sensitive than nonendangered species. Further, the variation in acute oral LD50s and dietary LC50s appears to indicate a difference in sensitivity between species.

The certainty of the above assessment is moderate to high. The major factor that affects the certainty (and prevents it from being high) is the variation in response among different species in the acute oral and dietary studies. For example, in the dietary studies tribufos ranges from slightly toxic to moderately toxic to practically nontoxic depending on the species tested. This variation in response increases the uncertainty of the assessment.

Chronic Risks

Chronic risks are likely for avian species, including endangered species, for all use rates of tribufos, whether applied as a single application or as a multiple application (two applications of

0.75 lb ai/acre, applied 10 days apart). For single, broadcast applications of nongranular product, RQs ranged from 1.03 to 3.04. For multiple, broadcast applications of nongranular products, and assuming maximum expected environmental concentrations (EECs) from 164 ppm to 358 ppm, RQs ranged from 1.11 to 2.42. For multiple, broadcast applications of nongranular products, and assuming an average EEC of 196 ppm, the RQ was 1.32.

The certainty of the above assessment is low to moderate. Two factors that affect the certainty (preventing it from being higher) are: (1) the lack of a mallard duck reproduction study; and (2) application of tribufos in the fall, a time when birds are not typically breeding. However, the long persistence of tribufos in the environment (i.e., tribufos is stable to hydrolysis, photolysis, and aerobic soil metabolism; soil aerobic metabolism half-life = 745 days) tends to offset the second factor. These factors, therefore, lead to a conclusion that while the possibility of chronic risk exists, the probability of whether it will occur is difficult to assess.

B. Mammalian Species

Acute Risks

Considering the calculated RQs and the available mammalian toxicity database from HED, acute risks to small mammals, including endangered species, are likely. For single, broadcast applications of nongranular products, the RQs for herbivorous and insectivorous mammals on various foot items ranged from 0.01 at an application rate of 0.75 lb ai/A to 2.23 for an application rate of 1.875 lb ai/A. For granivorous mammals, all acute RQs were $\leq$0.03. For multiple, broadcast applications of nongranular products totaling 1.50 lb ai/A, the RQs for herbivorous and insectivorous mammals on various foot items ranged from 0.02 to 1.77. For granivorous mammals, all acute RQs were $\leq$0.02.

The certainty of our assessment is moderate to high. Two factors that affect this certainty and prevent it from being high are: (1) a small mammal acute dietary LC50 study, which could represent dietary effects of tribufos better than the acute oral rat LD50 study, is not available to develop an acute risk quotient; and (2) it is not known how sensitive wild mammals may be to tribufos.

Chronic Risks

Chronic risks are likely for mammalian species, including endangered species, for single and multiple applications of tribufos. Several exposure scenarios were examined, including a 21-day exposure period, which should cover the shortest gestation period for a representative small mammal such as the white-footed mouse, *Peromyscus leucopus*. Even under this scenario, and using average estimated residues, chronic risk quotients were exceeded (RQs ranged from 6.38-13.94).

The certainty of the above assessment is high because:

1. The available chronic mammalian data appear to be scientifically-sound and provide values (NOEC and LOEC) related to effects on reproductive parameters (significant increase in dead pups in F1a and F2a litters).

2. Tribufos persists in the environment, allowing for chronic exposure of mammalian species.

C. Insects

EFED has no procedures for assessing risk to nontarget insects. Results of acceptable studies are used for recommending appropriate labeling precautions.

D. Aquatic Species

These assessments are based on exposure scenarios from three states: California, representing a dry climate; Mississippi, representing a wet climate; and Texas, a mixed climate.

a) California

1. Acute risks to freshwater vertebrates and invertebrates, including endangered species, are not likely.

2. A chronic risk characterization for freshwater fish is not possible; chronic effects data are lacking. However, chronic risks for freshwater invertebrates, including endangered species, are unlikely.

3. Use of tribufos in California is not expected to impact estuarine/marine environments. Acute and chronic risks to estuarine/marine vertebrates and invertebrates, including endangered species, are not likely.

b) Texas

1. Acute risks to freshwater vertebrates, including endangered species, are not likely from use of tribufos in Texas. However, a chronic risk characterization for freshwater fish is not possible; chronic effects data are lacking.

2. Acute risks to freshwater invertebrates may be mitigated by restricted use classification; however, chronic risks to these organisms is likely. Endangered freshwater invertebrates are likely to be affected acutely and chronically.

3. Acute risks to nonendangered estuarine/marine fish are not likely; however,

endangered estuarine/marine fish may be affected acutely. A chronic risk characterization for estuarine/marine fish is not possible; chronic effects data are lacking.

4. Acute and chronic risks to estuarine/marine invertebrates, including endangered species, are likely.

b) Mississippi

1. Endangered freshwater fish may be acutely affected. However, a chronic risk characterization for freshwater fish is not possible; chronic effects data are lacking.

2. Acute risks to estuarine/marine fish may be mitigated by restricted use classification. However, endangered fish may be affected acutely. A chronic risk characterization for estuarine/marine fish is not possible; chronic effects data are lacking.

3. Acute and chronic risks to freshwater and estuarine/marine invertebrates, including endangered species, are likely.

The certainty of the acute risk assessment is moderate to high. The available fish toxicity data are fairly consistent, ranging from moderately toxic to highly toxic. However, the available aquatic invertebrate toxicity data are more variable, ranging from moderately toxic to very highly toxic. This variation in response indicates differences in sensitivity between species and increases the uncertainty of the assessment preventing it from being high.

The certainty of the chronic risk assessment is moderate to high because:

1. The available chronic aquatic data appear to be scientifically-sound and provide values (NOEC and LOEC) related to effects on reproductive parameters. (Although a NOEC was not determined in the mysid life-cycle study, use of the LOEC in developing RQs still resulted in values well above the LOC of 1.0.)

2. Tribufos is likely to persist in the aquatic environment (hydrosoil) allowing for chronic exposure of aquatic species.

3. However, the absence of chronic fish studies affects the certainty and prevents it from being high.

E. Plants

The risks to nontarget terrestrial and semi-aquatic plants and to aquatic vascular plants cannot be assessed because pertinent plant studies are lacking. For aquatic nonvascular plants, risks are minimal, both for nonendangered and endangered plants. At an application rate of 1.875 lb ai/A, RQs for both plant types ranged from 0.0003-0.014.

The certainty of the risk assessment for plants is low because of the lack of pertinent terrestrial and aquatic plant data.

PLANT RISK ADDENDUM:

EEC Formulae

<u>Calculating EECs for terrestrial plants inhabiting areas adjacent to treatment sites</u>

Unincorporated ground application:
Runoff = maximum application rate (lbs ai/A) x
runoff value
Drift = maximum application rate x 0.01
Total Loading = runoff (lbs ai/acre) + drift (lbs ai/A)

Incorporated ground application:
Runoff = [maximum application rate (lbs ai/A) ÷
minimum incorporation depth (in.)] x runoff
value
Drift = maximum application rate x 0.01
(Note: drift is not calculated if the product is incorporated at the time of application.)
Total Loading = runoff (lbs ai/A) + drift (lbs ai/A)

Aerial, airblast, forced-air, and chemigation applications:
Runoff = maximum application rate (lbs ai/A) x 0.6
(60% application efficiency assumed) x runoff
value
Drift = maximum application rate (lbs ai/A) x 0.05
Total Loading = runoff (lbs ai/A) + drift (lbs ai/A)

<u>Calculating EECs for semi-aquatic plants inhabiting wet, low-lying areas</u>

Unincorporated ground application:
Runoff = maximum application rate (lbs ai/A)
x runoff value x 10 acres
Drift = maximum application rate x 0.01
Total Loading = runoff (lbs ai/A) + drift (lbs ai/A)

Incorporated ground application:
Runoff = [maximum application rate (lbs
ai/A)/minimum incorporation depth (in.)] x
runoff value x 10 acres
Drift = maximum application rate x 0.01
(Note: drift is not calculated if the product is incorporated at the time of application.)
Total Loading = runoff (lbs ai/A) + drift (lbs ai/A)

Aerial, airblast, and forced-air applications:

Runoff = maximum application rate (lbs ai/acre) x 0.6
(60% application efficiency assumed) x
runoff value x 10 acres

Drift = maximum application rate (lbs ai/A) x 0.05

Total Loading = runoff (lbs ai/A) + drift (lbs ai/A)